POWER

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DON'TS

For the Plant Owner

DON'T hire a first-class engineer to run your station and then worry him with fussy supervision in matters of routine importance.

Don't be afraid to trust the operation of your plant to an engineer who is "making good" and who gets the desired results by proper methods differing from those you might select yourself.

Don't expect to obtain the services of a specialist at the wages of a hodcarrier.

Don't hesitate to back up the engineer when he is right, no matter who thinks otherwise.

Don't forget that a visit to another station is stimulating to your engineer, even if you let him do it during business hours.

Don't "jump on" the plant chief when he recommends the expenditure of $100 to save $250, but get out your checkbook and when the saving materializes ponder a little about his value in your organization and act accordingly at appropriate intervals.

Don't assume that your engineer isn't earning his salary if you find him sitting in front of a cleared desk looking into space or reading the latest copy of his favorite technical journal. Many a keen idea comes to light on just such occasions.

Don't plan a lot of changes in your station without giving your engineer a chance to discuss them with you freely and without interruption.

Don't fail to give your "station boss" a vacation once a year at full pay.

Don't file your station log sheets and reports without looking them over and taking up with your engineer any points of interest. Few things are more discouraging to an operating man than to turn in painstaking records and charts merely to have them "put on ice" in the manager's office and rarely scrutinized with intelligent appreciation.

Don't forget that your engineer can help you in the purchase of supplies, if you avail yourself of his knowledge of how such material behaves and lasts in service.

Don't expect an engineer to look as neat as a soldier on dress parade when your power-station lavatory consists of a cold-water faucet and a tin basin.

Don't fail to visit the station some time after dark and note the lighting conditions under which the staff is obliged to labor, and don't balk at a reasonable outlay for improved lighting units if the "chief" so requests.

Don't take your consulting engineer through the plant without introducing him to the "chief." No outsider can do half so well without the co-operation of the man who lives on the job six or seven days a week, and the "chief" is entitled to be treated as one of your official family in all power-station matters.

Don't conclude that because the "chief" is an operating man he may not possess sufficient insight and executive ability to qualify him for promotion. Leaders have come from every sort of industrial task.

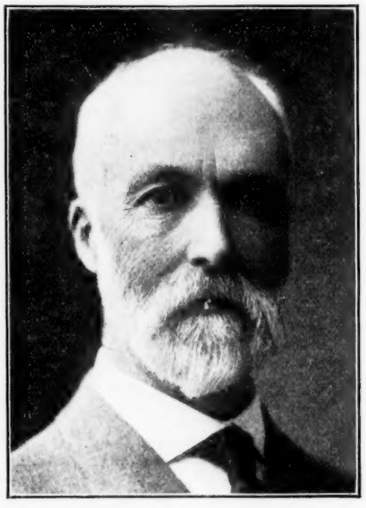
Don't abuse your engineer's confidence, and, per contra, he will not abuse yours.

Contributed by H. S. KNOWLTON, *Cambridge, Mass.*

Boston Is Ready for Its Power Show

Feeling the need of greater coöperation between themselves and power-plant engineers, particularly the National Association of Stationary Engineers in New England, the representatives of companies dealing in plant equipment formed, in 1911, the New England Association of Commercial Engineers. At the annual conventions of the New England States Association of the National Association of Stationary Engineers, the Commercial Engineers take charge of the mechanical exhibitions. Every other year they conduct the well-known Boston Power Show.

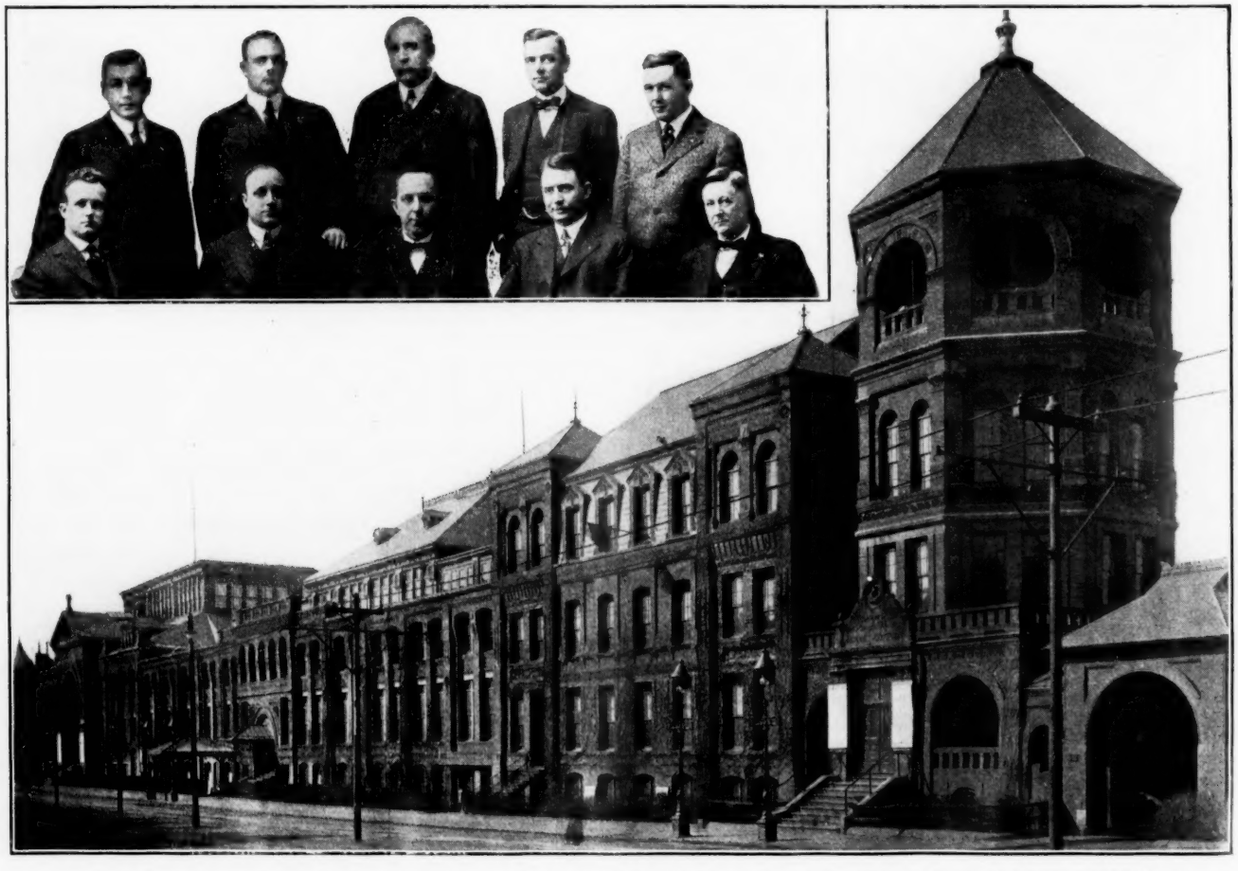
From April 24 to 29 the fifth National Textile Exhibition will be held jointly with the Power Show in the Mechanics' Building, Boston, and the two will make an exhibit surpassed only by the automobile show. The committee in charge of the Power Show consists of Bradford L. Ames, chairman, Claude D. Allen and Fred. M. Couch, all Boston business men.



FREDERICK H. BISHOP
President, National Textile Exhibition

The Commercial Engineers have a membership of 229, representing 200 companies. After the Power Show the next mechanical exhibit will be at Fall River, Mass., July 12-15, 1916, on the occasion of the convention of the New England States Association of the N. A. S. E. As New England is the country's greatest commercial and textile center, the shows will bring to Boston many interested in power-plant equipment and textile machinery.

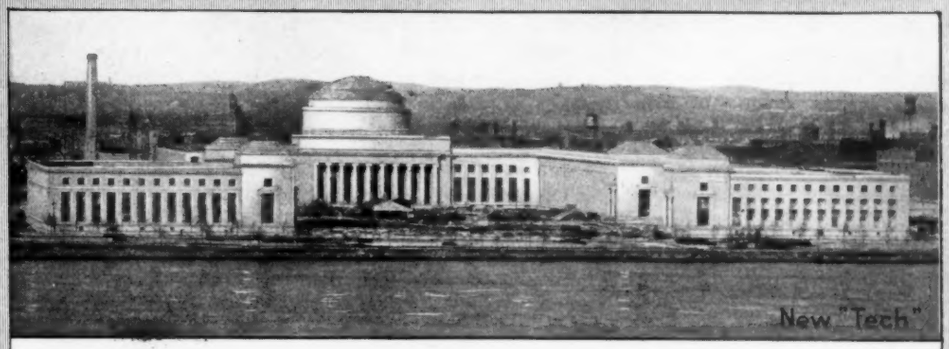
On the opposite page are a few of the many places of engineering interest in Boston. The New Massachusetts Institute of Technology is perhaps the best laid-out and provided engineering institution in the world. The site, on the Charles River, Cambridge side, is ideal. We have no authority for saying it, but we feel sure Prof. Edward F. Miller will be pleased to arrange for a visit if the party is big enough. The same is true for the other places shown. The club is one of the coziest you have ever slept and eaten in, and its location is truly beautiful. Other places of interest are: The Sargents Wharf Station of the Quincy Market Cold Storage and Warehouse Co., the largest refrigeration system in the world; the power stations of the Boston Elevated Railroad Co.; the Fish Wharf and Commercial Wharf; and the huge plant of the General Electric Co. in Lynn. The Board of Boiler Rules Department is worth a visit.



MECHANICS' BUILDING, WHERE THE SHOW WILL BE HELD; AND OFFICERS OF THE NEW ENGLAND ASSOCIATION OF COMMERCIAL ENGINEERS

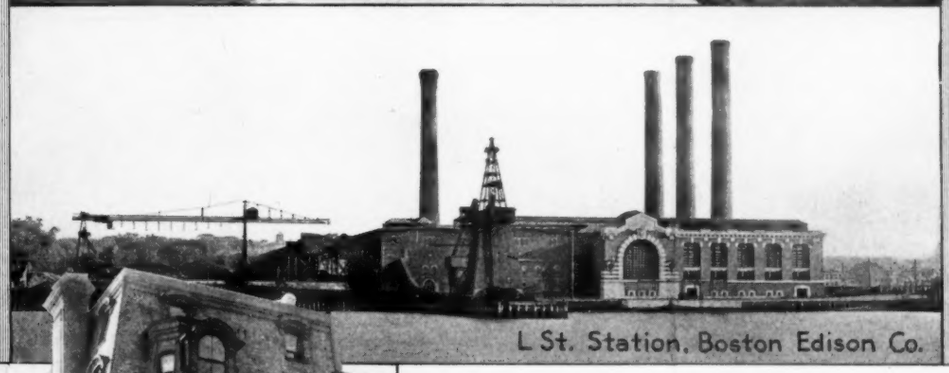
Left to right, top—Dudley G. Kimball, Bradford L. Ames, Herbert Stone, Harry M. Colby, Fred M. Couch. Bottom—Fred A. Foresman, Tremont S. Eggleston, Jr., James W. H. Myrick (president), Claude D. Allen, William K. Campbell

Greetings, Commercial Engineers!

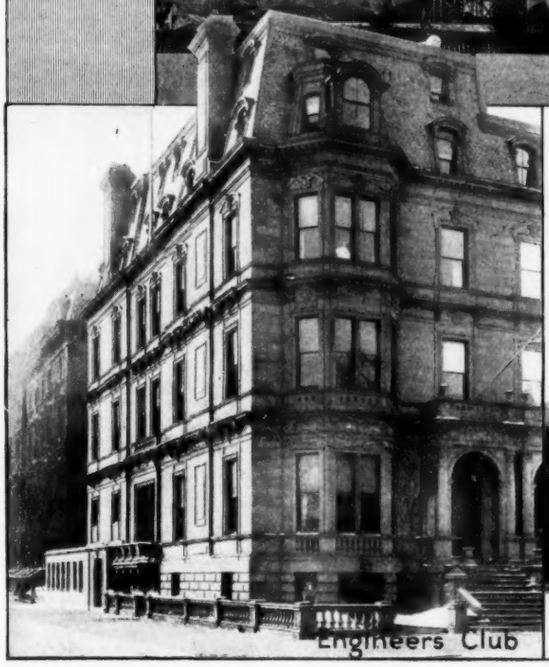


New "Tech"

Wentworth Institute



L St. Station, Boston Edison Co.



Engineers Club

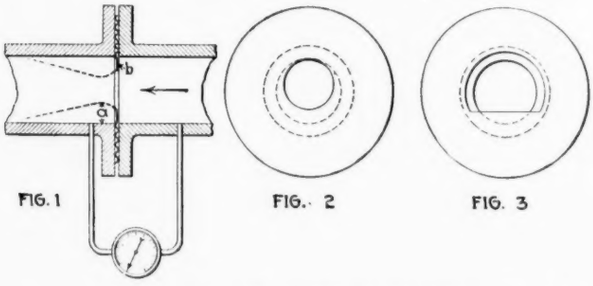
Franklin Union

The Bailey Steam-Flow Meter

SYNOPSIS—A new flow meter for liquids or gases, using a calibrated segmental or eccentric orifice and a compensating bell float indicating and recording mechanism.

E. G. Bailey, of Boston, is better known as a combustion engineer than as a maker of meters. As the head of the Fuel Testing Co., he established many interesting truths concerning the choice and handling of fuels and has made valuable contributions to the literature on the subject.

In the proving out under boiler-room conditions of the indications of analyses it was necessary to measure the amount of steam that a boiler was making from minute



FIGS. 1 TO 3. VARIOUS FORMS OF ORIFICE PLATE

to minute and the simultaneous supply of air to the furnace. This required a flow meter.

After an exhaustive series of experiments extended over more than two years, with pitot tubes, multiple-hole nozzles and calibrated orifices, he adopted a modified form of the latter as being the simplest and easiest to construct with the required degree of accuracy and as being free from the disturbing effects of obstruction to which small orifices are subject. The flow of steam through such an orifice, Fig. 1, produces a difference in pressure between the upstream and downstream sides of the plate, which

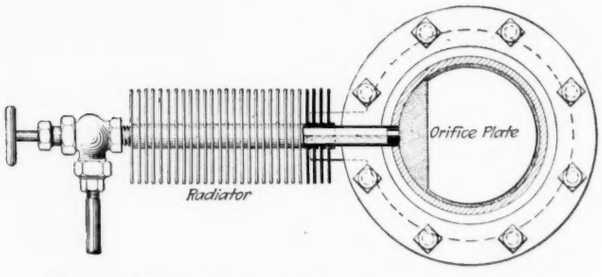
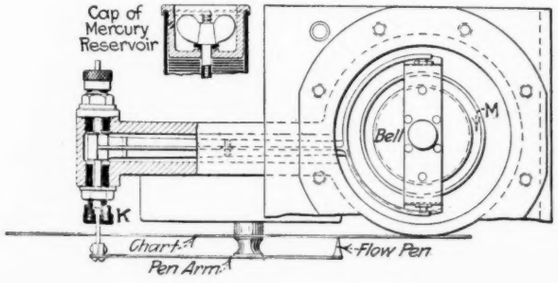


FIG. 4. SEGMENTAL ORIFICE AND CONDENSER

difference increases with the rate of flow, and when the relation of the pressure difference to the rate of flow is known, the metering becomes simply the reading or recording of the pressure difference in terms of the quantity flowing.

The first thought that naturally arises is that such an orifice will make an objectionable obstruction in the pipe and that any diminution in the pressure of the flowing fluid is undesirable. A fall of pressure of 1 lb. is, however, ample, and this is no greater than is incurred in going through an elbow or a globe valve. Experiments made at Mr. Bailey's instance, at the Ohio State University, and described by Prof. Horace Judd of that university at the recent spring meeting of the American Society of Mechanical Engineers,[1] showed that the distribution of pressure on the downstream side of the orifice followed the shape of a venturi nozzle, the greatest drop in pressure being at the point of greatest velocity just beyond the orifice, as shown by the dotted lines in Fig. 1, the pressure being restored as the full pipe suction is utilized and the velocity diminishes. It is understood, of course, that the entire cross-section of the pipe is filled with the steam or other fluid, only that which shoots through the orifice is moving faster than the rest, and that this leaves an area of low pressure at



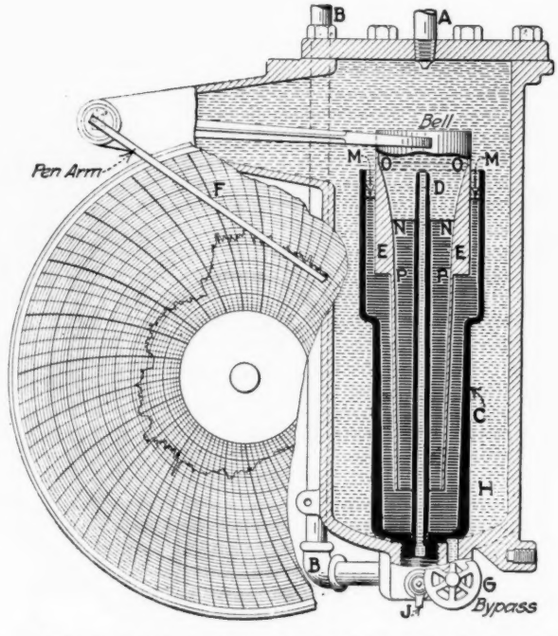


FIG. 5. BELL-FLOAT COMPENSATING RECORDER

a, the pressure difference at any point being proportional to the distance between the side of the pipe and the dotted line. It occurred to Mr. Bailey that it was unnecessary to produce a constriction all the way around the pipe to maintain a difference of pressure that needed to be measured only at one point. The upper portion *b* might as well be removed. Experiments showed that eccentrically placed orifices, Fig. 2, or segmental orifices,

[1] "Experiments on Water Flow Through Pipe Orifices," by Horace Judd. Presented at the New Orleans meeting of the A. S. M. E., April, 1916.

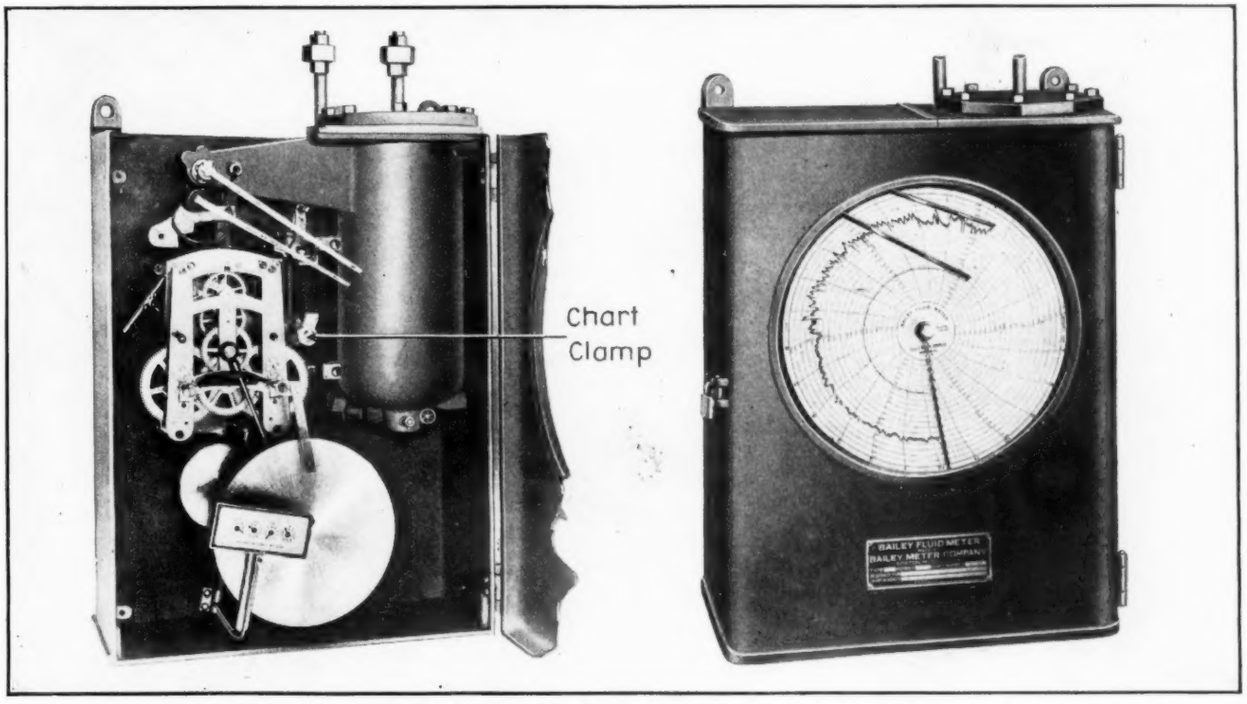
Fig. 3, give quite as satisfactory results as the centrally located circular type, make less obstruction and allow the designer to throw the region of lowest pressure to the point where it can be most conveniently measured. These experiments emphasize also the importance of the location of the downstream pressure connection with reference to the orifice plate.

The velocity, and thus the quantity flowing per unit of time, does not vary directly as the pressure difference, but as its square root. A pressure difference of 4 lb. would produce only twice as much flow as a pressure difference of 1 lb., and a pressure difference of ¼ lb. would produce one-half as much velocity as a pressure difference of 1 lb. The readings of a differential pressure gage, placed as in Fig. 1, would not therefore be a direct measure of the velocity and of the quantity flowing, and numerous devices have been used to make the index or recording pen move through equal divisions for equal increments in the rate of flow.

The apparatus used for measuring the pressure difference in the meter under review is shown in Fig. 5. The lower pressure, brought to the interior of the casing through the pipe *A*, acts upon the water with which the case outside of the mercury reservoir *C* is filled and presses downward upon the surface of the mercury at *MM*. The higher pressure, brought to the recorder by the pipe *B*, is communicated by the central pipe *D* to the water which fills the interior of the floating bell and presses downward upon the surface of the mercury at *NN* inside of the bell. The difference in the levels *M* and *N* is therefore a measure of the pressure difference.

When there is no pressure difference and the surfaces *M* and *N* stand level, the bell sinks until the line *OO* is at the level of the mercury and the thickened portion *EE* of the wall of the bell is entirely submerged. In this position the pressure inside the bell is effective upon the whole surface of the interior of the top of the bell to force it upward, while the same pressure forces the mercury downward. When there is a difference in pressure between the inside and the outside, the bell is lifted and the pressure within it acts downward upon the projected area of the metal that has emerged from the mercury, and counteracts the action of the same pressure upon a similar area of the top, leaving, as the area upon which the pressure is effective to lift the bell, that of the circle *N* occupied by the top of the inner column of mercury, including the area of the central pipe. When the weighted portion of the bell *EE* is submerged in the mercury, it tends to float and exerts no downward pull upon the bell, but when it emerges from the mercury it commences to bear, and, just as a log lifted from the water is harder and harder to lift the more of it that is exposed, so as more and more of the wall *E* emerges from the mercury it hangs back harder and harder upon the bell and makes it more difficult to lift.

There are, therefore, two restraints upon the ascent of the bell, both of which increase as the bell rises—the diminishing area of the circle *NN* and the increasing mass of the portion of the wall *EE* that protrudes above the mercury. Both of these depend upon the shape of the curve *ONP*, and it is possible to make this curve such that the lift of the bell will be in proportion to the square root of the pressure difference, so that equal movements of the pen arm *F* operated by the bell will indicate equal increments of flow, and charts that have uniform spacing and that can be easily integrated or averaged may be used. The volume of metal *E* made to emerge from the mercury by an increment of pressure is equal to the amount of mercury that would have to be displaced to balance the increase in pressure difference. If the bell were held stationary, an increase of pressure would push the mercury down at *NN* and up at *MM*. Thus as the bell rises under the action of such an increase, the room that the metal *EE* leaves is enough to let the mercury in the



FIGS. 6 AND 7. INTERIOR AND EXTERIOR VIEWS OF BAILEY FLOW METER

outside tube remain at the level *M*, which maintains the zero of the scale constant.[2] A bypass *G* connecting the base of the riser *D* with the space *H* outside the bell allows the pressures inside and outside the bell to be balanced and the instrument to be adjusted for zero conditions. The bell is weighted by a ring which, however, is not shown in the plan nor in the elevation in Fig. 5. This ring is carried by a yoke over the top of the bell and hangs so low as to bring the center of gravity of the bell and its attachments below the point of suspension, thus securing the stability of the apparatus under all conditions. A pet-cock *J* drains the central tube *D*. When the instrument is shipped, the mercury reservoir is removed and handled separately, a cap held on by a wing-nut on the threaded top of the standpipe, as shown in the detail in Fig. 5, securing the contents.

Automatic Seal Against Loss of Mercury

Another feature of this meter is the automatic shutoff, which prevents blowing out of the mercury or other damage when either of the pressures is excessive, owing to an abnormally high rate of flow, improper opening of valve or even the breaking of one of the connecting pipes. In case the higher pressure exceeds the lower pressure by an amount corresponding to the maximum rate of flow, the bell will be pushed to its extreme top position and a soft packing held between the top end of the bell and the bell-weight yoke, which is exposed through a hole in each, will close the opening in the tube, thereby bottling up the water, which completely fills the casing and prevents the forcing of mercury out of the reservoir. In a similar way the tube is sealed when the bell is forced down against it by an excessive pressure in the upstream pipe.

An effective method of getting the movement of the bell-arm spindle through the wall of the casing, which is filled with water under the full pipe pressure, has been found in the pressure-tight bearing *K*, Fig. 5. The protruding portion of the spindle is reduced to a small diameter. The packing consists of a thin disk of pliable material and has a hole of the right diameter to make a joint that is practically frictionless and yet free from leakage. The packing is not confined in a closed recess and is free to expand sidewise away from the spindle when the nut is tightened. It is impossible, therefore, to vary the friction by turning down on the nut, and the friction is so negligible that a duplicate is used on the other end of the spindle, relieving the end thrust.

Use of Compensating Condensers

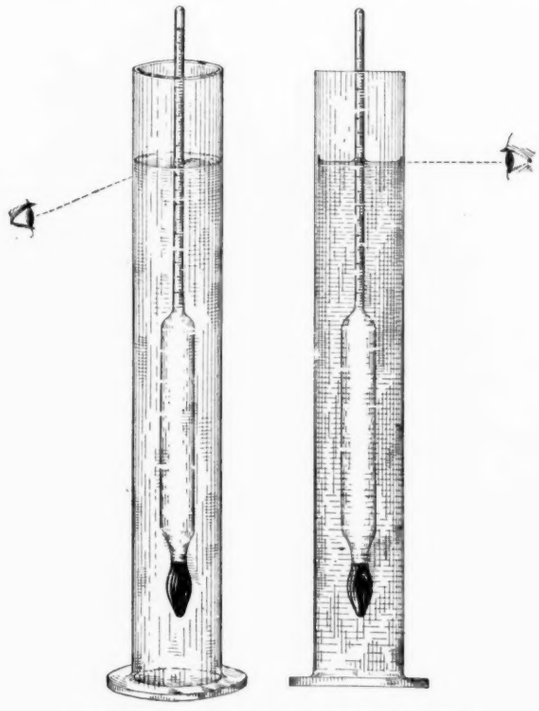
The pressure upon one side of the differential pressure gage in Fig. 1 is the pressure upon the upstream side of the orifice plus the head of water in the connecting pipe, and the pressure upon the other side is that upon the downstream side of the orifice plus the head of water in its connecting pipe. In order that the indication of the differential gage may be a correct measure of the pressure difference on opposite sides of the orifice, the two columns of water must balance each other. It will be seen that any movement of the bell, in Fig. 5, will draw water from one of the connecting pipes and displace it from the other, thus inducing a difference of head. To keep this disturbance within an immaterial range, under conditions of rapid fluctuation, it would be necessary to have the connecting pipes very large, or to have unwieldy reservoirs connected with them. Mr. Bailey has avoided this by providing radiators upon the connecting pipes, as in Fig. 4, which condense sufficient steam to replace any water that may be withdrawn promptly enough to avoid any serious distortion of the record. This drawing shows also one of the segmental orifices in position. These orifices are made of $\frac{1}{32}$-in. monel metal with corrugations like the old-time copper gasket, so that each forms its own packing. The velocity of flow is not sufficient to cause corrosion or cutting. Numerous tests have established values for orifices of different shapes and sizes.

It was while engaged in this series of calibrations that the idea occurred to Mr. Bailey of measuring large quantities of flowing fluid by injecting into it a known amount of CO_2 or some other substance, and by determining the proportion of CO_2 at the delivery to deduce the quantity flowing. Figs. 6 and 7 show the interior and exterior of the meter, which may carry pens for recording the temperature, pressure or other quantities upon the same chart. These meters may be used for the measurement of all sorts of fluids, liquids or gases, and are made by the Bailey Meter Co., 141 Milk St., Boston, Mass.

[2] A complete mathematical description of the floating-bell type of compensating recorder is given by its inventor, J. W. Ledoux, "Transactions American Society of Civil Engineers," Vol. 76, 1913.

How To Read the Hydrometer

The correct method of reading the hydrometer is illustrated in Figs. 1 and 2, reproduced with the directions for reading from Circular No. 57 of the United States



HOW TO READ THE HYDROMETER

Bureau of Standards. The sample of oil is placed in a clear glass jar or cylinder and the hydrometer carefully immersed in it to a point slightly below that to which it naturally sinks, and is then allowed to float freely.

The reading should not be taken until the oil and the hydrometer are free from air bubbles and are at rest. In taking the reading the eye should be placed slightly below

the plane of the surface of the oil (Fig. 1) and then raised slowly until this surface, seen as an ellipse, becomes a straight line (Fig. 2). The point at which this line cuts the hydrometer scale should be taken as the reading of the instrument (Fig. 2).

If the oil is not sufficiently clear to allow the reading to be made as described, it will be necessary to read from above the oil surface and to estimate as accurately as possible the point to which the oil rises on the hydrometer stem. It should be remembered, however, that the instrument is calibrated to give correct indications when read at the principal surface of the liquid. It will be necessary, therefore, to correct the reading at the upper meniscus by an amount equal to the height to which the oil creeps up on the stem of the hydrometer. The amount of this correction may be determined with sufficient accuracy for most purposes by taking a few readings on the upper and the lower meniscus in a clear oil and noting the differences.

A specific-gravity hydrometer will read too low and a Baumé hydrometer too high when read at the upper edge of the meniscus. The correction for meniscus height should therefore be added to a specific-gravity reading and subtracted from a Baumé reading.

The magnitude of the correction will obviously depend upon the length and value of the subdivisions of the hydrometer scale and must be determined in each case for the particular hydrometer in question.

The Boston Fish Pier Plant

SYNOPSIS—Boston's million-dollar fish pier on the harbor at the southern end of the city has four 200-ton compressors and 200 tons' ice-making capacity. The pier is a little city in itself.

It was to concentrate the commercial and industrial operations of the immense fish trade carried on in Boston that the million-dollar Fish Pier was built. The plant has four Frick vertical ammonia compressors of 200 tons each, driven by Lentz poppet-valve engines; these are shown in Fig. 1. The compressors are set on 12-in. walls instead of the usual heavy foundations. The engine cylinders overhang; the floor being cut away under the cylinder, there is plenty of room to work on the exhaust valves. The operator can appreciate what this means. There are four 300-hp. steel-inclosed Erie City boilers each having Taylor stokers. The ashpits are open at the front, and to a person standing in front of them, they look much like horse or cattle stalls, except that the floors incline toward the observer. The ashes are hand-shoveled. The windboxes and air duct for the stokers are of concrete. There is no steel in the boiler-room walls, which are of concrete. Should coal get afire in the 1,200-ton overhead bunker, it may be dropped through chutes into the bucket conveyor in the basement and conveyed into the yard. The chimney is of concrete, 155 ft. high; its thickness is from 10⅜ in. at base to 4 in. at the top, with a 4-in. core all the way up. It was built in January, steam coils being used inside to prevent freezing. The feed-water piping is of wrought iron instead of the usual brass. The two steam condensers have 2,000 sq.ft. of cooling surface each. Before going to these condensers the circulating water passes over the atmospheric ammonia condensers. Some of this water is used for thawing ice from the 600-lb. cans on the top floor. The ammonia condensers have 30,720 ft. of 2-in. pipe.

Although 1,200 hp. is served, the steam pipe is only 8 in. in diameter, giving approximately 12,000 ft. per min. as the steam velocity. The pressure is 175 lb.

To appreciate the Fish Pier you must see it. It is a little city in itself, the power plant furnishing it with light, heat, power and refrigeration. Thousands of lobsters are cooked by steam supplied at 10 lb. pressure. There is approximately 80,000 sq.ft. of radiation in the heating system; the inlet pressure is 1½ lb., while a

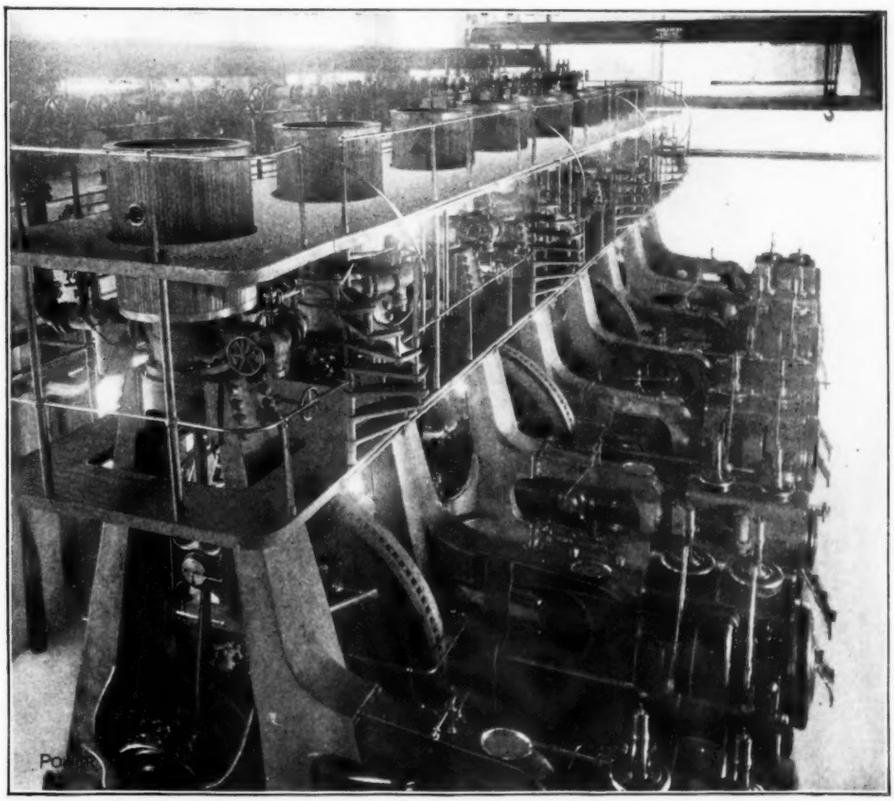


FIG. 1. FOUR 200-TON AMMONIA COMPRESSORS, BOSTON FISH PIER

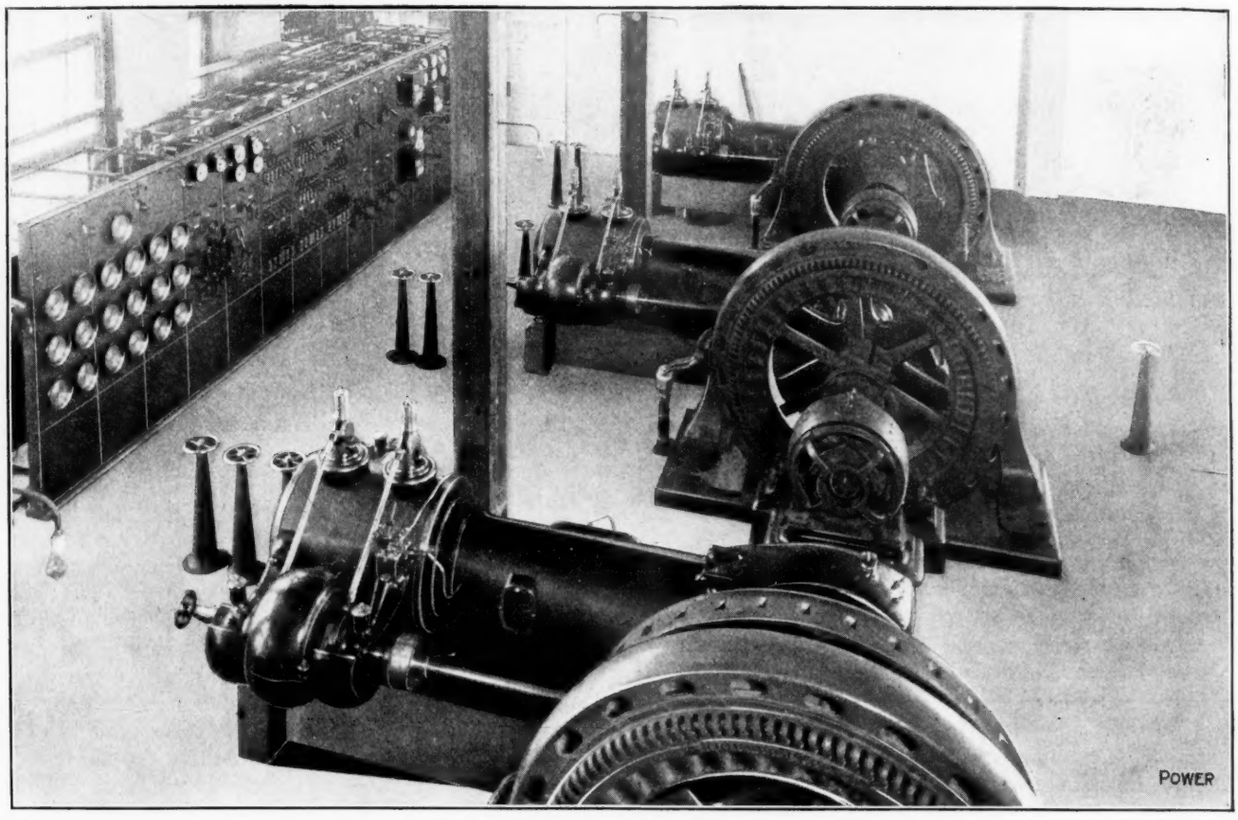


FIG. 2. ELECTRIC GENERATING EQUIPMENT IN THE FISH PIER PLANT

pump maintains 20 in. vacuum at the return. Consumers are charged a flat rate based on the number of square feet furnished. The charge for electricity is the same as the Boston Edison Co.'s rates. Refrigeration is sold according to a rate based on the surface of pipe exposed in the refrigerators. Although the ice-making capacity is but 200 tons per day, the demand on some summer days when scores of boatloads of fish are brought from the sea, is 700 tons. Naturally, a large icehouse is required. Electric current at 240 volts is furnished by Triumph generators driven by Erie City Lentz engines (see Fig. 2). One of the typical guarantees on the engines was 11⅜ lb. per indicated horsepower-hour at 150 lb. pressure, 100 deg. superheat and 26 in. vacuum.

Starrett & Benners of Portland, Ore., were the engineers.

Fundamental Principles of Alternating Current--VI

By F. A. Annett

SYNOPSIS—This is the final article of the series, taking up in an elementary manner the principles of alternating currents. The relations in the three-phase star and delta connections are here explained.

The alternating-current system that is used more at present than any other is the three-phase, therefore the present discussion will deal with some of the factors entering into this system.

If three conductors are spaced 120 deg. apart in a two-pole magnetic field, as shown in Fig. 59, and revolve about an axis as indicated by the dotted circle, each conductor will generate a sine wave of electromotive force just as did the single conductor in Figs. 7 and 8 (part 1, Dec. 7, 1915, issue). Since the conductors differ in location by 120 deg. the e.m.f. generated in them will differ in phase by 120 electrical or time degrees. Rotating the conductors in the direction of the curved arrow will induce in them, at the instant shown, an e.m.f. in the direction indicated by the dot and cross in the center of the circles representing the conductors. The direction of the e.m.f. in A is up through the plane of the paper, while that induced in B and C is away from the reader. Furthermore, conductor A at this instant is on the vertical axis of the magnetic field and is therefore generating a maximum pressure, while conductors B and C are located in the position between the vertical and horizontal axis and are therefore generating an e.m.f. of a value somewhere between zero and maximum. Just what this value is can probably best be explained by a vector diagram.

In Fig. 60 on the vertical axis YY' lay off OA representing to scale the maximum value of the e.m.f. generated in conductor A. Next draw OB 120 deg. in a clockwise direction from OA making OB represent

to scale the maximum e.m.f. generated in conductor *B*. Since *B* travels through the same path and at the same rate as *A*, the maximum e.m.f. in *B* will equal that in *A*, therefore *OB* will equal *OA*. Draw *OC* 120 deg. in a clockwise direction from *OB* to represent to scale the maximum e.m.f. generated in *C*. For the reason already set forth, *OC* will also equal *OA*. The positions of *OA*, *OB* and *OC* correspond to the positions of the conductors *A*, *B* and *C* respectively in the magnetic field, as represented in Fig. 59.

The projections of *OA*, *OB* and *OC* on the vertical axis will represent to scale the value of the e.m.f. generated in the conductors at this instant, as explained in part 4 (Feb. 8 issue). Since *OA* coincides with the vertical axis *YY'*, its projection on this axis will be equal to its total value, which indicates that the e.m.f. generated in *A* at this instant is at a maximum. By projecting *OB* horizontally to *YY'*, distance *Ob* is obtained; this represents to scale the instantaneous value of the e.m.f. generated in *B*. The projection of *OC* also gives the value *Ob* for the e.m.f. generated in *C*. This is what would be expected when the positions of *B* and *C* in the magnetic field are considered, as both are in similar positions but under opposite sides of the polepiece; hence at this instant the voltage generated in each will be equal.

In an earlier article of this series it was explained that the instantaneous value *e* of the e.m.f. can always be found by the formula: $e = \text{Max. } E \text{ sine } \phi$. In Fig. 60 the value of ϕ with reference to *OB* and *OC* equals 120 deg. — 90 deg. = 30 deg. Sine 30 deg. = 0.5, hence $e = \text{Max. } E \times 0.5$. That is, *Ob*, which represents to scale the value of the e.m.f. generated in *B* or *C* at this instant, is equal to one-half that generated in *A*, which is at a maximum value. The voltage generated in *B* and *C* at this instant is in the same direction, therefore the combined e.m.f. of *B* and *C* is equal and opposite to that in *A*. For the direction of motion shown, the e.m.f. in *B* is decreasing while that of *C* is increasing.

When the conductors have revolved 30 deg. from the position of Fig. 59, they will be located in the magnetic field, as indicated in Fig. 61. This brings *B* on the horizontal axis, therefore the pressure in it has decreased to zero, and *A* and *C* occupy similar positions in the magnetic field, but under opposite polepieces; consequently the e.m.f. generated in them at this instant will be equal and opposite. This condition is shown in the vector diagram, Fig. 62. Since *OB* coincides with the horizontal axis, its projection on the vertical will be zero, and this corresponds with the value of the e.m.f. generated in *B*. The horizontal projections *Oa* and *Oc* on the vertical axis represent the values of the e.m.f. generated in *A* and *C* at this instant respectively. Since angle $\phi = 60$ deg. for either *OA* or *OC* the e.m.f. generated in *A* will equal that generated in *C*, but will be opposite in direction. Since $\phi = 60$ deg., and sine 60 deg. = 0.866, $e = \text{Max. } E \times 0.866$. In other words, the voltage generated in *A* and *C* at this instant is 0.866 times the maximum value. Again, it is evident that the sum of the e.m.f. generated in the conductors under one polepiece is equal and opposite to that generated under the other polepiece.

What has been shown for the two positions of the three conductors—namely, the sum of the e.m.f.'s generated in the conductors under one polepiece is equal and opposite to the sum of the e.m.f.'s generated in the conductors under the other pole—is true for any position. This is illustrated in Fig. 63, which shows the curves generated by the three conductors, Figs. 59 and 61. Since the conductors are 120 deg. apart, the curves will also be displaced from each other by 120 time degrees. Referring to the instant marked *a* on the curves, it is seen that curve *A* is at a maximum above the time line when *B* and *C* are at half value below the line, which

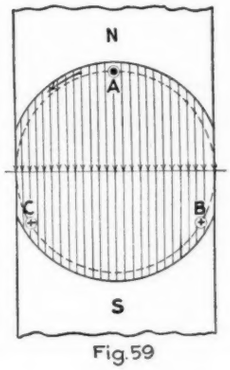


Fig.59

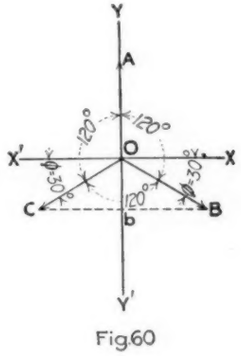


Fig.60

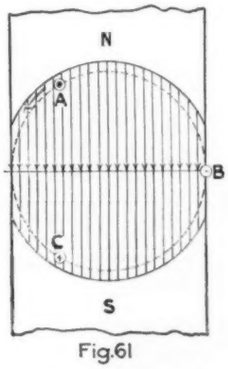


Fig.61

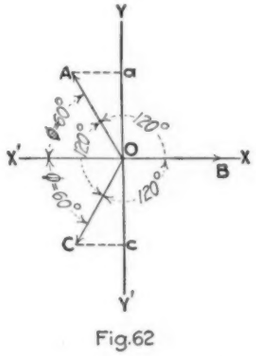


Fig.62

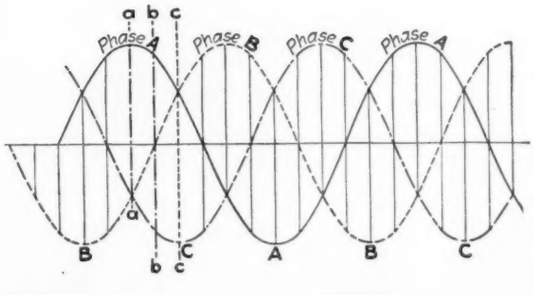


Fig.63

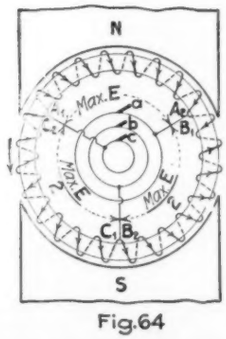


Fig.64

Fig.65

FIGS. 59 TO 65. REPRESENTING RELATIONS IN THREE-PHASE CIRCUIT

indicates they are opposite in polarity to A, which is just the condition represented in Fig. 59. At the instant marked b on the curves, which is 30 deg. from a, the value of B has decreased to zero, while that of A has decreased and that of C increased until they are the same value but in the opposite direction; which is the same condition as that represented in Fig. 61. *At any instant the sum of the instantaneous values above the line is equal to the sum of the values below the time line.*

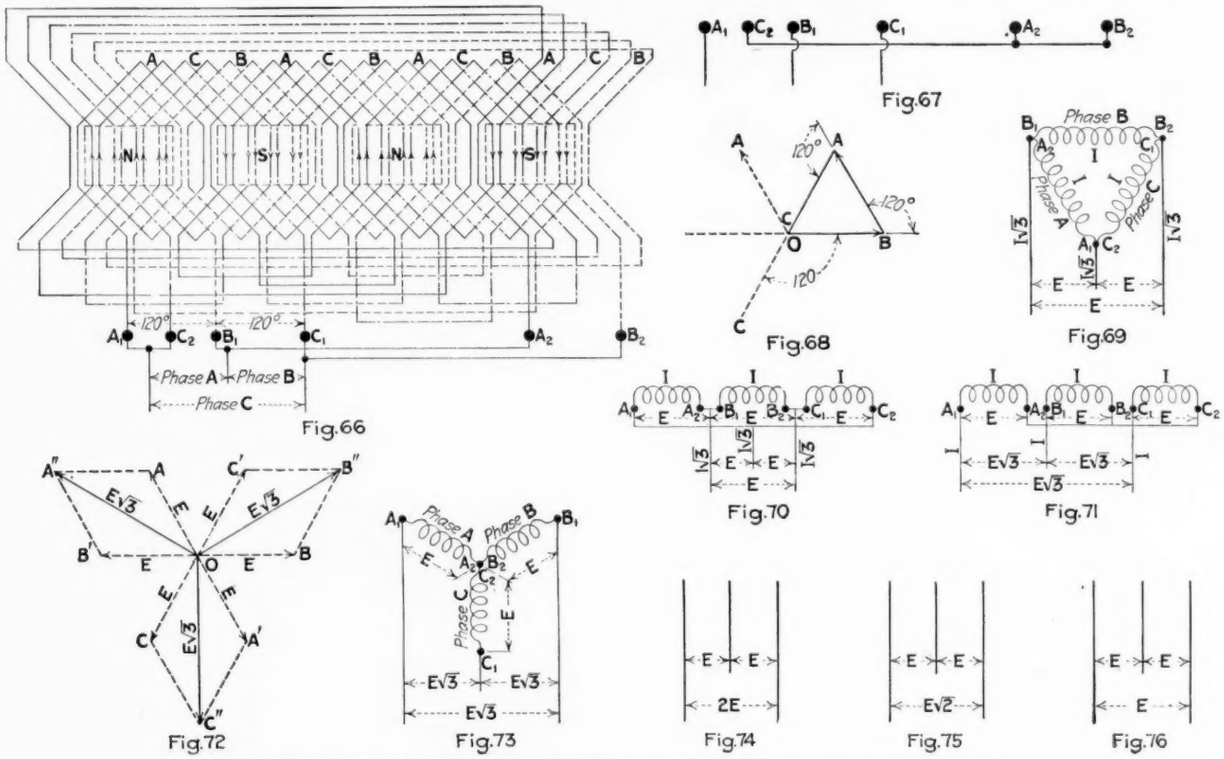
What has been explained for three conductors revolving about an axis in a magnetic field is also true for three groups of conductors located 120 deg. apart, as represented in the ring armature, Fig. 61. Here the same arrangement of coils and polepieces is used as that for the one- and two-phase machines, but in this instance the winding is connected at three equidistant points to three slip-rings. Considering the position of the armature shown, it will be seen that the conductors between A_1 and A_2 are in a position to generate a maximum e.m.f. Between B and B_2 the voltage in a 30 deg. section of the winding above the axis XX' is in opposition to that below this axis, therefore this will leave only a 60-deg. section of the winding effective to the right of B_2 to produce e.m.f. between B_1 and B_2; this is just one-half of that between A_1 and A_2 at this instant. For the same reason the pressure is only one-half between C_1 and C_2 that it is between A_1 and A_2. This is just what existed in the three conductors, Fig. 39.

If the armature is turned through 30 deg. as in Fig. 65, the e.m.f. between B_1 and B_2 will decrease to zero, as the voltage generated in one-half of the winding between these two points is opposite to that generated in the other half, as indicated by the arrow-heads. It is evident also that the e.m.f. between A_1 and A_2 is equal to that between C_1 and C_2, but in the opposite direction. This corresponds to the condition in Fig. 61, also as illustrated on the three-phase sine curves at the point marked b, Fig. 63.

The three different groups of conductors on the armature, Figs. 64 and 65, have generated in them the same series of values of e.m.f., therefore the voltage between any two of the brushes will be the same. Hence we have a three-wire system having three equal voltages displaced in phase by 120 deg. This is just the condition in a three-wire three-phase circuit.

In a commercial machine, instead of using a ring windings, as in Figs. 64 and 65, three windings are used, one for each phase, distributed in groups according to the number of poles. One type of such a winding is shown diagrammatically in Fig. 66. This winding has 24 coils grouped for a four-pole machine, which gives two coils per pole per phase; each individual group is lettered A, B, and C respectively. It may at first seem difficult to reconcile the connections in Fig. 66 with those in Figs. 64 and 65. In Fig. 64, A_1 the beginning of phase A is 120 deg. from B_1 the beginning of phase B; likewise, C_1, the start of phase C, is 120 deg. from B_1.

In this case the windings are not only 120 electrical degrees apart, but also 120 space degrees apart, but as referred to before, this is true only in a two-pole machine. On a four-pole machine 60 space degrees are equal to 120 electrical degrees. When considering the four-pole winding in Fig. 66, B_1, the beginning of phase B, will be only 60 space degrees away from A_1, the beginning of phase A. This is equivalent to 120 electrical degrees, as indicated on the figure; likewise for C_1, which is 120 deg. from B_1. After the coils have been grouped in their respective phases and the terminals of each phase brought out, the phases may be grouped as in Fig. 64; A_2, the ending of phase A, is connected to B_1, the beginning of phase B, B_2 to C_1 and C_2 to A_1, and leads are brought out from each of the junction points. By



FIGS. 66 TO 76. REPRESENTING THREE-PHASE WINDINGS AND GROUPING

tracing out the circuit in the windings, Fig. 66, it will be seen that the voltage in phases A and B is one-half the maximum value and in the same direction, but opposite to that in C, which is at a maximum. This corresponds to the point marked c on the curves Fig. 63.

This scheme of grouping the three phases is called a delta (Δ) or mesh connection. When combined in this manner, they form an equilateral triangle, as indicated in Fig. 68. Frequently the windings are shown diagrammatically connected in the form of a triangle, as in Fig. 69 or as in Fig. 70. At first thought it may appear that the three windings are connected so as to cause a short-circuit. It is obvious that this is not the case when it is remembered that the e.m.f.'s in a three-phase circuit are in such a relation that their algebraic sum at any instant is equal to zero, therefore the potential between points A_1 and C_2, Fig. 70, is zero. In the delta-connected winding it is evident that the voltage between terminals is that per phase. The current per terminal cannot be the current per phase, as each leg of the circuit connects to two different phases; therefore the current leaving or entering at any one of the junctions between the phases will be some resultant of the current in the two phases. In a balanced three-phase system (that is, where the current in each phase is the same value) which is delta-connected, the current per terminal will be that of one phase times the square root of three. If the current per phase is represented by I, the current per terminal will equal $I\sqrt{3}$. The correct relation of voltage and current in a three-phase delta-connected system is indicated in Figs. 69 and 70.

Connecting A_2 to B_2 as in Fig. 71, changes the relation of the e.m.f. in phase B by 180 deg. from that in Fig. 70; hence, if OA, OB and OC, Fig. 72, represent the phase relation of the three e.m.f.'s of Fig. 70, OB' will represent the relation of the e.m.f. in phase B to that of phase A when connected as in Fig. 71. Here it is seen that the e.m.f. in A and B differ by only 60 deg. instead of 120 deg.; combining the two vectorially, the resultant OA'' is obtained, which represents to scale the value of E between A_1 and B_1, Fig. 71. Connecting C_2 to B_2 changes the voltage relation of phase C by 180 deg. In Fig. 72, if OC represents the position of the e.m.f. in phase C with reference to that in phase B, Fig. 70, OC' will represent the phase relation of the e.m.f. in phase C to that in phase B, Fig. 71, which indicates that the e.m.f. in C differs in phase by only 60 deg. from that in B. Completing the parallelogram, the resultant OB'' is obtained, which represents to scale the value of E between the terminals B_1 and C_1. C_2 is also connected to A_2 instead of A_1, as was done in Fig. 70. This changes the relation of the e.m.f. in phase A to that in phase C by 180 deg., and is indicated by OA', Fig. 72, and the resultant OC'' gives the value of E between the terminals C_1 and A_1. This combination gives three equal resultant e.m.f.'s 120 deg. apart; the value of these resultants in terms of E per phase is indicated on the diagram. Such a combination as represented in Fig. 71 is called a Y (gamma) or star connection.

The value of the e.m.f. between terminals with a star connection is equal to the voltage of one phase times the square root of three. If E represents the e.m.f. per phase, then $E\sqrt{3}$ represents the voltage between terminals. It is evident that the current per terminal in the star connection is the same as that per phase as indicated in Fig. 71. The star connection is sometimes represented by the conventional Fig. 73. Fig. 67 shows how to group the three windings of Fig. 66 in a star connection.

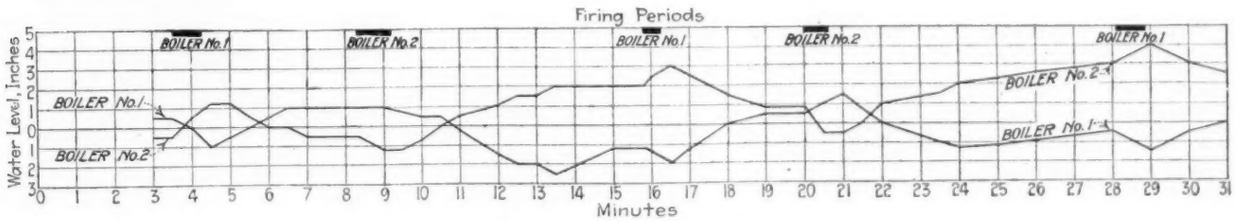
Alternating-current generators may be wound for any number of phases, but in practice they are never constructed for more than three. Alternating-current systems of more than one phase are referred to as polyphase systems, such as, a two- or a three-phase system.

In general there are three types of three-wire circuits: (1) The Edison three-wire system, where the voltage between the two outside legs of the circuit is twice that between either outside and center leg, as in Fig. 74; this system may be either direct or alternating current. (2) A three-wire two-phase system, in which the potential between the two outside terminals is that between the outside and center terminal times the square root of two, as indicated in Fig. 75; such a system can be alternating current only. (3) The three-wire three-phase system, either delta- or star-connected; in this combination the voltage between any two terminals is the same as shown in Fig. 76, and can be alternating current only. Obviously either system may be easily identified by the voltages between its terminals.

Stopping Water-Level Fluctuations

By T. B. Hyde

While visiting a boiler plant the writer's attention was called to a circumstance that was giving the operating force considerable concern. The plant consisted of two hand-fired Babcock & Wilcox boilers of the cross-drum type, rated at 150 hp. each, set in battery and connected to one stack by a horizontal breeching.



CURVES SHOWING HOW THE WATER FLUCTUATES WHEN THE BOILERS ARE FIRED

It seemed that when one boiler was fired, the water level dropped in the gage of that boiler and at the same time rose a corresponding amount in the other. The firemen thought there was an interchange of water from one boiler to the other and were worried. The writer thereupon recorded the water level of each boiler every 30 sec. and also the time and duration of each firing. These data are shown herewith. The water level is in inches above or below the center of the gage-glass for

each boiler. The duration of each firing period is indicated by a heavy line above the water-level lines.

At each firing the water level dropped about one inch in the gage of the boiler being fired, while at the same time the level in the other rose an equal amount. As soon as the fire-doors were closed, conditions began to return to normal. A pyrometer was placed in the breeching and inclined draft gages connected to read the draft over the fire of each boiler. It was found that when a fire-door was opened, the stack temperature rose 10 to 20 deg. F. and the draft over the fire of the other boiler showed an increase of 0.02 to 0.03 in. of water. The reasons for the variation were then apparent.

When a fire-door is opened, the inrush of cold air strikes the front tubes and checks the circulation, which results in a drop of water level. This same inrush of air carries the combustion-chamber temperature back toward the rear of the boiler, raising the stack temperature, which in turn produces an increase in the draft over the fire of the other boiler. This increased draft, although slight, accelerates the circulation, resulting in a higher water level.

The boilers in this plant were equipped with two fire-doors each. We will number the doors, from left to right across the boiler fronts, 1, 2, 3 and 4. When these observations were taken, the men were in the habit of firing doors 1 and 2 at one firing and doors 3 and 4 at the next. The doctrine of "firing light and often" was preached, and the men were instructed to fire but one door at a firing and to fire in the order 1, 3, 2, 4. Thus the doors of a boiler were open only one-half as long at a given time, the chilling effect was not so great as before, and the recovery was quicker. As a result the variation in water level was reduced to a maximum of ½ in., and by close attention could be reduced to an almost imperceptible amount.

An Engineer's Phantom Warning--II

By W. O. Rogers

SYNOPSIS—Westcott relates another of his experiences with a phantom woman. This time she discovers cracked spokes in an engine flywheel and attempts to stop the engine, whereupon Westcott thinks it about time to take a hand in the proceedings and does the trick himself.

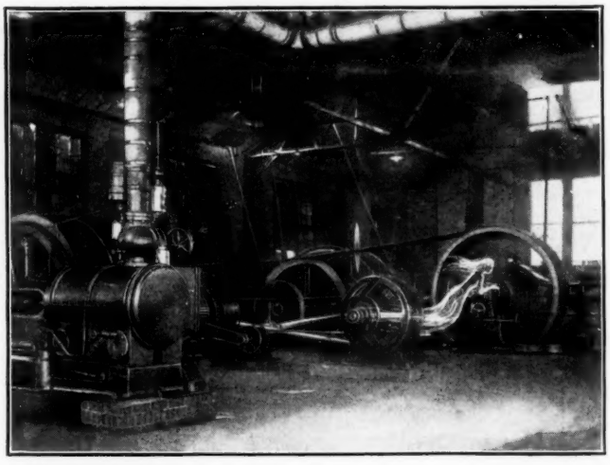
One evening while taking a stroll and smoking an after-dinner cigar, I dropped around to Westcott's plant. He had just made his rounds and stood in the doorway of the engine room as I came up. It was a pleasant starlight evening. A heavy mist rose from the pond close by the plant, and a gentle air current at times caused the vapor to assume various shapes as it drifted across the pond. Westcott was watching this when I broke in upon him.

"That mist," said he, "reminds me of the time when I was running a belt-driven power plant in a small town. Did you even have a premonition that something was about to happen? Well, I have had a lot of them, and it's a strange sensation the first few times. That mist lifting out there," and he pointed toward the pond, "recalls a little incident that probably saved the trouble of a funeral. The plant was on the outskirts of the town and just across the road from a cemetery. On a pleasant night the tombstones glistened in the moonlight, and along about midnight a fellow would get the shivers if he happened to be superstitious, although I never gave the matter a thought.

"Well, early in the evening of this particular night a severe thunder storm had come up and the wind had caused the short-circuiting of a couple of uninsulated feed lines. You can imagine how the sparks flew at the generator brushes, because the circuit-breakers stuck for a while. That brought a severe strain on the engine, but after the trouble had been attended to by the linemen, we started up again and ran along as usual. I did, however, notice that there was a clicking in the flywheel, but gave the matter no attention at the time, never thinking for a moment that anything was wrong.

"Along about midnight I was seated at my desk, thinking it was about time to eat a little lunch, when I felt impelled to look toward the engine flywheel that made the noise. Well, sir, I nearly lost my breath, for there, floating by the end of the crankshaft was my phantom lady, apparently absorbed in examining the flywheel as if trying to determine the cause of that clicking that I had hardly noticed.

"I watched to see what would take place, and I was convinced that something was wrong with the engine be-



FLOATING AT THE END OF THE CRANKSHAFT WAS THE PHANTOM LADY

cause of her presence. I don't remember that I felt concerned as to any immediate danger, but I knew something was about to happen. Suddenly there came a slight, sharp snap, and instantly the phantom lady became all action. She looked at me, then at the flywheel and then back at me. Seeing that I made no move, she beckoned impatiently and made a twirling motion with her hand, as if shutting a throttle valve."

"What did you do?" I asked, shifting my weight from one foot to the other. "Rushed to the engine and shut it down, I suppose."

"No, I didn't; leastwise not just then. You see we had been down once during the evening, and I didn't want to stop that engine before morning. But at the same time I knew that my phantom lady was not monkeying about that engine just because she had nothing else to do. That was what made me undecided, and so I just watched.

"My phantom seemed undecided just what to do and so stood there and wrung her hands as a woman does when greatly distressed. Then all at once she listened and then floated to the throttle wheel and attempted to stop the engine, meanwhile looking over her shoulder at me and alternately tugging at the throttle and pointing to the flywheel."

"She was almost human," I remarked, with sarcasm, as I borrowed a match from Westcott.

"She showed more understanding than I did," was his short answer. "When she began trying to turn that throttle, I concluded that it was about time to do something, and I made a rush job of getting another machine up to speed; after throwing over the load, I stopped the engine that had caused my phantom so much anxiety. My next move was to examine that flywheel, and I can tell you that I was not much surprised to find two of the spokes cracked close to the rim.

"In the rush of getting the engine stopped I had forgotten the lady in white, and when I turned around to look for her, she was gone. Glancing upward, I just caught a glimpse of the bottom part of her dress disappearing through the roof. Rather strange, wasn't it?"

Westcott gazed absently toward the pond where the mist was still rising, mechanically filled his black corncob pipe and, after lighting it, said: "I never ran that engine again because I got a better job the following week. The company patched the spokes after I left, although I urged them to get a new flywheel. I didn't believe that it was safe for the speed it ran and refused to take a chance with it, which accounted for my sudden change of address. That was a case where flywheel insurance and inspection would have been an advantage, for the cracked spokes would not have been repaired had the wheel been insured."

"Did the wheel last with the new engineer?" I asked, as Westcott made a movement toward going into the engine room.

"It lasted one night and went to pieces at about 9 o'clock the second evening, wrecking the engine and the generator, besides cutting a steam pipe and shutting down the plant. The funny part of it was that the new engineer was blamed for the accident and was fired the next day."

"Evidently your lady friend did not make him a visit of warning," I suggested, as I threw the cigar stub into the pond, where it sank with a hiss.

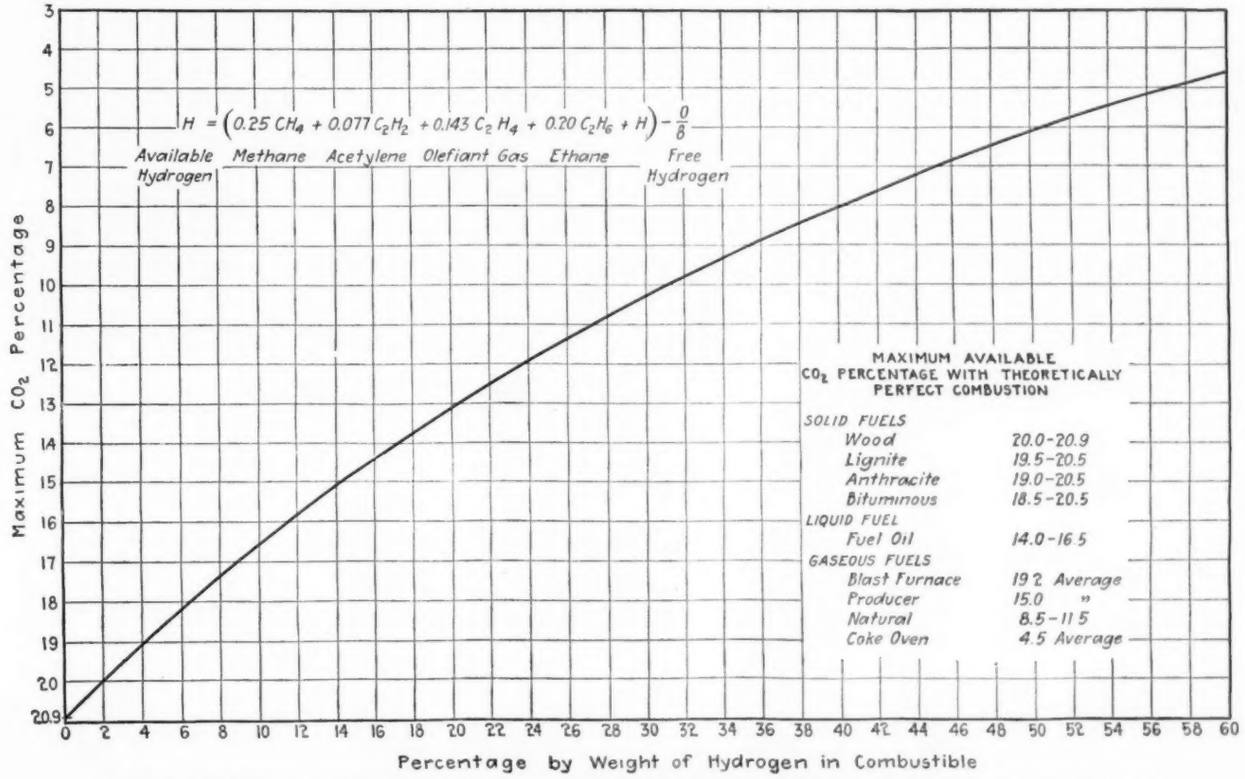
"I guess not," replied Westcott, "but I have always been glad that I shut down that engine when I did."

I left the plant with the determination to look up the matter of supernatural visitations and see if others had had similar experiences, although I never did, for there was a doubt in my mind whether or not Westcott was having a lot of fun at my expense.

CO_2 Available with Fuels of Varying Hydrogen

By Victor J. Azbe

The accompanying chart, giving the maximum available CO_2 with fuels containing different amounts of hydrogen and when burned at theoretically perfect combustion, should be of interest in these days when boiler-room performances are being so widely discussed and improved.



CURVE SHOWING AVAILABLE CO_2 AT THEORETICALLY PERFECT COMBUSTION WITH FUELS OF DIFFERENT HYDROGEN CONTENTS

Large Turbine for Providence

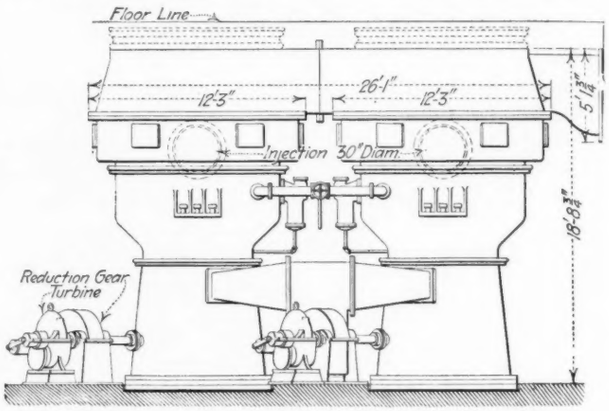
SYNOPSIS—A cross-compound unit having a continuous rating of 45,000 kw. and an overload rating of 50,000 kw. for the Narragansett Electric Lighting Co. It will have the largest jet condenser yet constructed.

To meet the demands of increased business the Narragansett Electric Lighting Co., of Providence, R. I., has contracted for a 45,000-kw. turbo-generator to be installed in its South Street station. This will be a Westinghouse machine of the cross-compound type, larger than, but similar in construction to, the units now in operation at the Seventy-fourth Street station of the Interborough Rapid Transit Co., New York. (See *Power*, Apr. 20, 1915.)

Although the continuous rating of the Narragansett machine is 45,000 kw. at 95 per cent. power factor, it will be capable of carrying for short periods a load of 50,000 kw. It has been designed for maximum efficiency at about three-fourths the continuous rating, at which point it is understood the guaranteed steam consumption is close to 11½ lb. per kw.-hr., increasing to about 11.9 lb. at full load. That is, at the most economical load the steam passes through all the blades of the high-pressure element; above this the first group of blades is bypassed by admitting steam through the secondary valve to the second group, and still further an overload is carried by the tertiary valve admitting steam to the third group of blades.

The high-pressure element is of the single-flow, straight reaction type receiving steam at 175 lb. and 100 deg. superheat through a 24-in. inlet and exhausting at approximately atmospheric pressure through an overhead connection to the low-pressure element. The high-pressure casing is of cast steel, the entry blades are 4 in. long, the final blades 7½ in. and the mean blade speed approximately 225 ft. per sec.

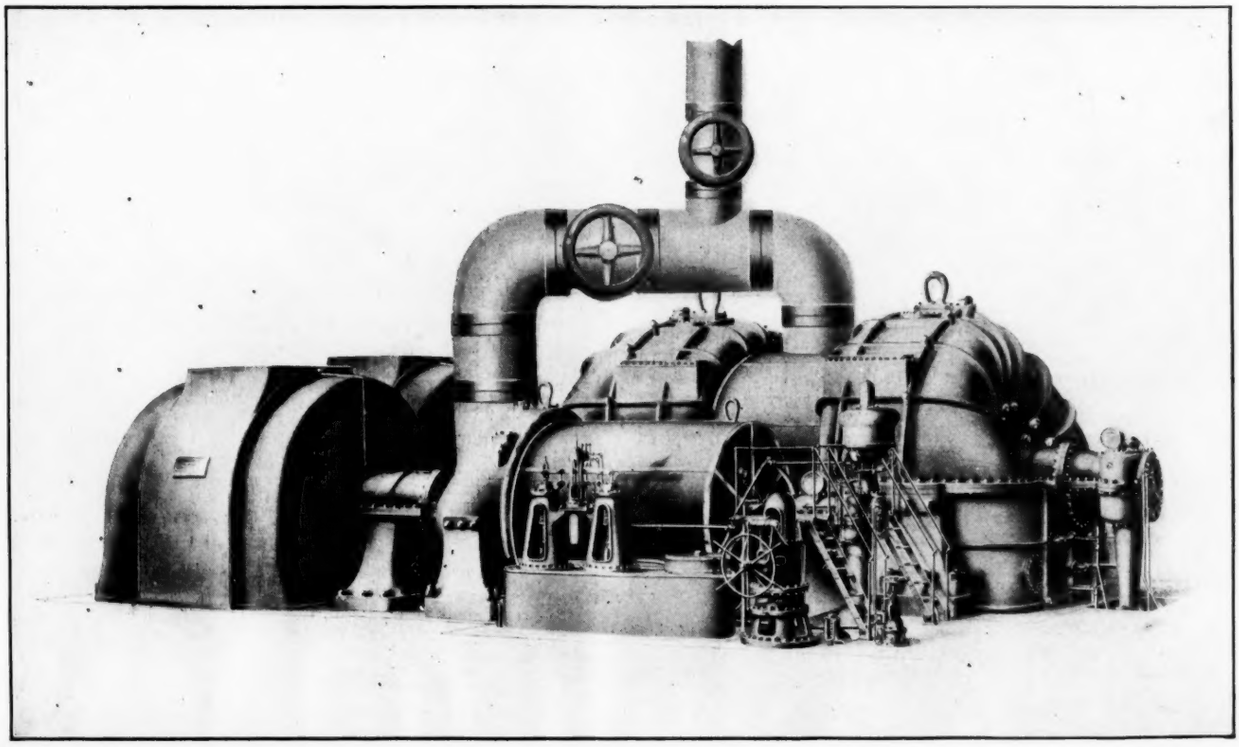
The low-pressure element is designed on the double-flow principle, with eight groups of blades on either side



LARGEST JET TYPE CONDENSER

and each side exhausting into a separate condenser of the jet type. The entry blades are 6 in., the final blades 18 in., and the low-pressure casing is of cast iron.

There are of course two generators, that driven by the high-pressure turbine being a four-pole machine running at 1,800 r.p.m. and the other a six-pole machine running at 1,200 r.p.m. Both will generate three-phase 60-cycle current at 12,000 volts and will be built with sufficient internal reactance to keep the short-circuit current within



45,000-KW. CROSS-COMPOUND TURBINE FOR NARRAGANSETT ELECTRIC LIGHTING CO.

limits. Each will have an independently driven exciter of about 100 kw. capacity and 250 volts.

Complete, the unit will measure 46 ft. 9 in. long, 37 ft. 2 in. wide and 18 ft. 6 in. high over all, and the estimated total weight is 1,300,000 lb. Figured on the maximum continuous rating this represents about 26 kw. per sq.ft. of floor space and a unit weight of 29 lb. per kw.

Owing to the condition of the cooling water available, it is inadvisable to use surface condensers at this plant. The condenser that is to serve this turbine will be the largest of the jet type yet constructed. It will be of the Westinghouse-Le Blanc low-head design and will be proportioned to handle 18,000,000 lb. of circulating water per hour, condensing approximately 500,000 lb. of steam per hour when maintaining a vacuum of 28 in. with water at 70 deg. This is equivalent to 36 lb. of circulating water per pound of steam.

In this design of condenser the suction on the circulating water is maintained by the vacuum, and the mixture of water and condensed steam is removed from the bottom of the shell by a double-suction centrifugal pump. The air pump, mounted on the same shaft, draws from around the cone at the top.

In the present case there will be practically two condensers—one connected to either end of the low-pressure turbine and capable of operating independently. Each will have its own set of pumps, driven through reduction gears by a small turbine. There will also be a motor-driven priming pump, to be used in starting the condenser. The steam-inlet passage to each condenser will be approximately 29 sq.ft., the discharge pipe will be 30 in. diameter and the air-pump discharge 14 in.

Gasoline- or Kerosene-Driven Air Compressor

A new design of air compressor has just been put on the market. It is a portable, self-contained, two-stage

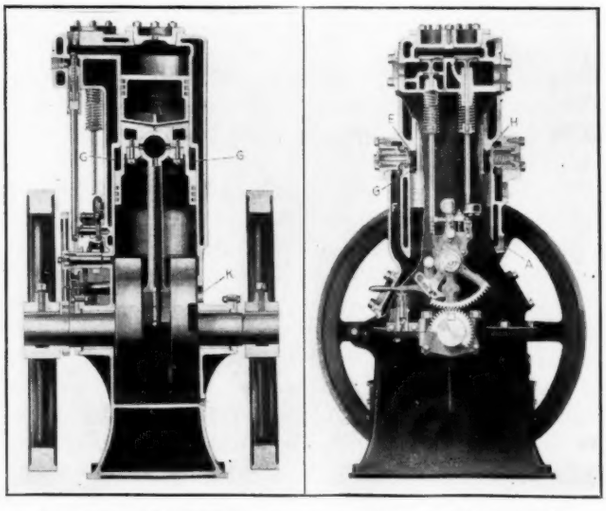


FIG. 1. FRONT VIEW FIG. 2. SIDE VIEW

vertical type and is driven by either a four-stroke-cycle gasoline or a kerosene engine. The power and air cylinders are contained in a single casting, with one crank, one connecting-rod and one differential piston. The outfit is made in several sizes—from 35 to 150 ft. per min. to pressures up to 200 lb.—by the Lyons Atlas Co., Indianapolis, Ind.

The speed of the engine is regulated by an inertia weight pivoted to the bell crank which carries the exhaust roller. At speeds above normal the weight stretches a spring which, through connecting parts, holds the suction valves shut and the exhaust valves open during the suction stroke. When the speed falls below normal, the spring relaxes and the regular cycle is resumed.

There are two air-compressing strokes to one working stroke of the engine. The final air pressure is reached through two stages of compression. When the air piston is at the top of its stroke, the crank case is full of air at atmospheric pressure, admitted through the port *K*, Fig. 1, which registers with a port in the crank disk. On the downward stroke this air is compressed in the crank case and then flows through the passage *F*, Fig. 2, and valve *E* into the annular chamber *G*, and raises the absolute pressure in it to approximately 20 lb. The valve *E* closes as the piston starts on the upward stroke, and as soon as the pressure in the space *G* reaches the receiver pressure, the discharge valve *H* opens, allowing the air to pass into the receiver during the remainder of the upward stroke.

The same water is used for cooling the engine and the compressor cylinder. The cold water is first used for cooling the air cylinder, and the heated water then passes through the engine cylinder. It is first taken through the opening *A* at the bottom of the air-cylinder jacket, and then passes upward and around the air cylinder.

An unloading device is furnished extra, by means of which the air-admission valve between the crank case and the annular chamber is held open when the pressure reaches a predetermined point, thus removing the load from the engine and allowing it to run light until the pressure falls below the maximum for which the unloader has been set.

Hot-Water and Steam Heating

By Ira N. Evans

"Which is the better system for house heating, hot water or steam?" is a question frequently asked those in the heating business. From the standpoint of efficiency and service it is possible to obtain just as good results with steam as with hot water, and it is also possible to install either at nearly the same cost, or with a less difference in cost than between the highest and the lowest bid for either on the same plans. The following experiences show that the designer and operator have more to do with the satisfactory operation than the type, whether a steam, hot-water or so-called vapor system.

The author had occasion recently to investigate two complaints—one of a steam and the other of a hot-water heating plant. Fig. 1 is a combined single- and double-pipe steam system. Line *C* is on the first-floor ceiling supplying single-pipe radiators on the second floor. Line *D* is also on the first-floor ceiling connecting double-pipe radiators on the floors above. Line *E* is in a trench under the first floor and forms a return for radiators *F* and *B*.

Radiators *A* would not heat with less than seven lb. pressure, but at that pressure radiators *B* loaded up with water and failed to operate. There was only 4 ft. between

radiators *B* and the water line of the boiler, and the supply connection, being in the bottom, would naturally be sealed. Radiators *F* worked all right under all conditions.

It had been suggested that hot-water radiators be installed in place of the steam radiators *B*, with the supply connection in the top. This would have assisted somewhat, but if the water level in the returns was halfway up on the radiator, the results would not be very satisfactory. There seemed to be no real good reason why radiators *A* should not work under all conditions, but it was found that the air valves were on the supply end and steam came up both supply and return pipes, causing the radiators to become air-bound.

The wide range of pressure in the boiler caused the water level to fluctuate, and when the pressure was reduced during firing periods, the boiler flooded with the water held in the returns and allowed the line to clear and the radiators *B* to heat.

The higher pressure called for by the radiators *A* and the difficulty of maintaining it constant caused a waste of fuel. Closing the supply valves on the radiators *A* and getting rid of the air caused them to heat perfectly through the return, even when the pressure was reduced to 3 lb. or less, so the surplus water was drawn from the boiler and the job worked satisfactorily.

If the radiators *A* had been connected on a single pipe in the first place, the plant would have given no trouble and the cost would have been less.

Shortly afterward a hot-water plant that had been installed about four years in a four-story clubhouse, with about 1,000 sq.ft. of direct radiation and the usual two-pipe connections, was inspected on complaint of insufficient heat and waste of fuel. The boiler was of cast iron of a well-known type of excellent design and was rated at about 1,000 sq.ft. on a steam basis.

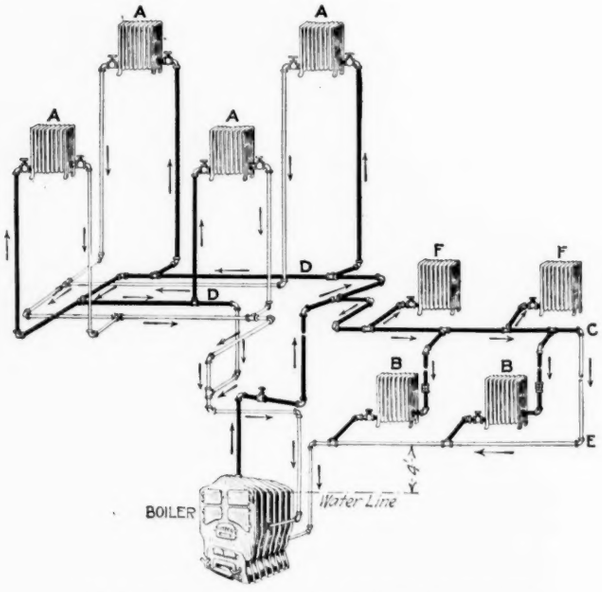


FIG. 1. TWO SYSTEMS OF PIPING COMBINED

The attendant stated that he could not maintain the heat on the system for any length of time; by forcing the fire he could obtain about 180 deg. for short intervals, but after an hour or two his fire would be burnt out, and while replenishing it the apparatus and building would become cold. The coal consumption was of course excessive under these conditions.

It had been recommended that the plant be changed from hot water to steam at considerable expense for labor and extra valves on the radiators, etc. This could not possibly remedy the matter, as the trouble was that the boiler was too small, although rated to take care of the radiation connected. It might have been of sufficient capacity to serve 1,000 sq.ft. of radiation in a room the temperature of which was 70 deg., but was inadequate for a room temperature of 50 to 60 deg. and the same radiation.

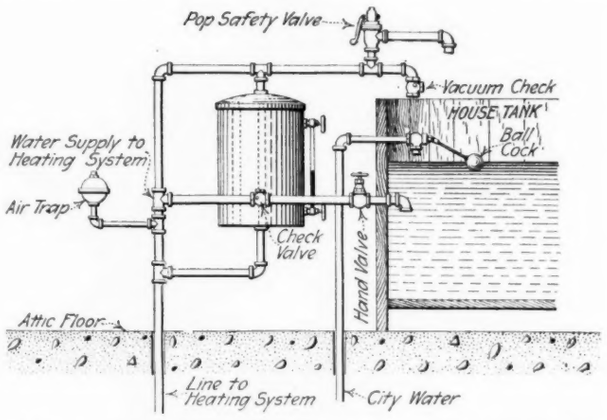


FIG. 2. EXPANSION TANK PIPED TO ADD PRESSURE

Heating surface is computed to maintain a temperature of 70 deg. in the room with zero outside, with continuous operation, but the boiler power would have to be approximately doubled if required to raise the room temperature with the same radiation. The change to steam would increase the temperature of the medium and thereby add to the work required of the boiler.

I recommended that three or four intermediate sections be added to the boiler so as to increase its capacity 50 per cent.; also that the present expansion tank be arranged as shown in Fig. 2 in order to obtain a slight pressure and consequently higher temperature in the system. The tank is supplied by a large house tank in the attic, served by a city water line and the level in which is regulated by a ball-cock and float.

In the connecting line there should be a hand valve and a check valve to prevent the pressure blowing through to the house tank and yet supply water when the level in the expansion tank is below that required.

A water relief valve set at 5 lb. pressure with overflow into the house tank is also to be connected, and a vertical check valve to prevent a vacuum forming a false water level in the expansion tank, and an air trap connected slightly below the required water level in the expansion tank. This arrangement will provide an automatic water supply and allow a pressure to be carried on the system that will give a temperature of 215 to 220 deg. F., and the pop valve will prevent any danger of excessive pressure on the piping or radiators.

The operation of the expansion tank as rearranged is as follows: When the water is cool, the air trap will admit air and allow the water to flow in through the check valve until the pressure of air above the water equals the head in the house tank. As the water becomes hot and expands, a pressure is created up to the limit

of the safety valve (51 lb.), which will close the check between the house tank and expansion tank.

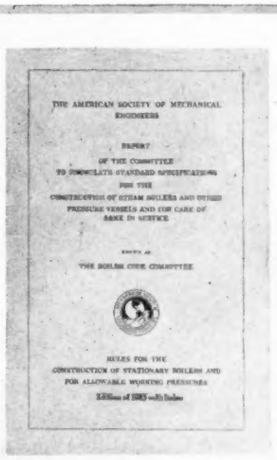
If there was no vacuum check valve, the water level in expansion tank being slightly above that required to close it, the air trap might prevent the water level from lowering and admitting water from the house tank.

This arrangement will require no change in the piping or methods of operation and will enable the hot-water system to be operated at steam temperatures, thus doing away with increasing the amount of radiation.

Without increasing the heater capacity, it would be useless to change the plant to steam, as this would require the same increased boiler capacity owing to the higher temperature of the heating medium.

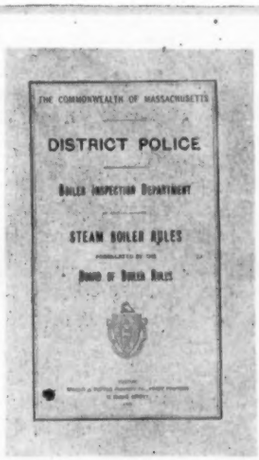
These two cases are typical of the general troubles on both steam and hot-water systems, and it is readily seen that there is more difference in the installation due to the ideas of the designer than there is inherently in the heating medium.

The temperature being the same, there is but slight difference between steam and hot-water heating plants, except that the water has the advantage of a wider range in temperature. In either case the same size of boiler is needed for economical operation.


THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
REPORT
OF THE COMMITTEE
THE CONSTRUCTION OF STEAM BOILERS AND OTHER
PRESSURE VESSELS AND FOR CARE OF
SAME IN SERVICE
THE BOILER CODE COMMITTEE
RULES FOR THE
CONSTRUCTION OF STATIONARY BOILERS AND
FOR ALLOWABLE WORKING PRESSURES

The A.S.M.E. Code AND THE Massachusetts Rules -A Comparison

By Stanley P. Stewart.



SYNOPSIS—The author sets forth the chief points of difference in the requirements of the Boiler Code of the American Society of Mechanical Engineers and the Rules of the Massachusetts Board of Boiler Rules.

The writer attempts to give an outline of the conspicuous and important differences between the boiler Code of the American Society of Mechanical Engineers and the Rules of the Massachusetts Board of Boiler Rules. Where no specific mention is made of parts of either it may be understood that there is substantial agreement between the two. The terms Code and Rules will be used to designate each.

The Code is divided into two main divisions, Part 1 and Part 2. The former deals with new installations exclusively and is divided into Sections 1 and 2 relating to power boilers and heating boilers respectively. Part 2 deals with existing installations and is necessarily limited in scope to avoid serious interference when it is incorporated into law. An appendix is added, containing tables and examples of an explanatory nature.

The Massachusetts Rules are divided as follows: Part 1, in addition to Part 2, applying to boilers installed on or before May 1, 1908; Part 2 applying to all boilers now or hereafter installed; Part 3, in addition to Part 2, applying to boilers installed after May 1, 1908; Amendments, adding to or modifying Parts 2 and 3 and applying to boilers installed after July 2, 1915.

The Code is divided into paragraphs, the substance of each group being indicated by subheadings as follows:

Paragraphs 1-13, Selection of Materials, wherein is specified what material shall be used for various parts.

Paragraphs 14-16, Ultimate Strength of Material Used in Computing Joints, in which allowable unit stresses forming the basis for calculations are given.

Paragraphs 17-22, Minimum Thickness of Plates and Tubes.

Paragraphs 23-178, Specifications for Boiler-Plate steel, rivet steel, stay-bolt steel, steel bars, steel castings, gray-iron castings, rivet iron, stay-bolt iron, wrought-iron bars and tubes.

Pause and make comparison with the corresponding provisions in the Rules.

The accompanying table gives the comparison of the requirements called for in Paragraphs 1-13 and 23-178 covering selection of materials and specifications for them.

The specifications are given in more complete detail as regards mill tests, etc. in the Code than in the Rules and, with the exception of tubes, are substantially the same as those of the American Society for Testing Materials. The Rules state that all plates and tubes used in the construction of steel shells or drums of boilers shall be as specified by the American Society for Testing Materials.

Paragraphs 14-16 on strength of materials differ only in the values given the strength of rivets in shear, as follows:

	Code, Lb.	Rules, Lb.
Iron rivets in single shear	38,000	38,000
Iron rivets in double shear	76,000	70,000
Steel rivets in single shear	44,000	42,000
Steel rivets in double shear	88,000	78,000

Paragraphs 17-20 on the minimum thickness of plates embrace the following differences from the Rules: Mini-

mum thickness of dome plates after flanging are specified; minimum thickness of tube sheets tabulated is confined to horizontal return-tubular boilers. The Rules require that the thickness of plates in a shell or drum shall be of the same gage.

The requirements specified in Paragraphs 21 and 22 for the minimum thickness of tubes used in water-tube and fire-tube boilers are not found in the Rules.

Beginning with Paragraph 179 of the Code, under the heading, "Construction and Maximum Allowable Working Pressure for Power Boilers," follow detailed rules for determining strengths and efficiencies of shells, drums, joints, ligaments, etc., with examples, and stating in what way the work shall be done.

Paragraph 179 allows a boiler to be operated at a higher pressure than the maximum allowable working pressure (as found by these rules) when the safety valve or valves are blowing, but it shall not be exceeded by more than 6 per cent., an allowance not found in the Rules.

Efficiency of the Joints

In Paragraph 181 (Code), the efficiency of a joint is defined and the method of calculation stated and the appendix referred to for detailed methods and examples. These examples and the results obtained are the same as given in the Rules except that a quintuple-riveted butt-strap joint is shown and calculated and a butt-strap joint with straps of equal width and a saw-tooth joint are illustrated as allowable joints. The difference in allowable shearing strength of rivets does not change the results obtained, as the efficiencies are governed, in every case given, by the strength of plate between rivet holes in the outer row. Paragraph 182 gives specific directions not found in the Rules regarding the distances between any two adjacent rows of rivets with minimum sections allowed between them.

Paragraph 184 (Code) specifies that:

The strength of circumferential joints of boilers, the heads of which are not stayed by tubes or through braces, shall be at least 50 per cent. that of the longitudinal joints of the same structure. When 50 per cent. or more of the load which would act on an unstayed solid head of the same diameter as the shell is relieved by the effect of tubes or through stays, in consequence of the reduction of the area acted on by the pressure and the holding power of the tubes and stays, the strength of the circumferential joints in the shell shall be at least 35 per cent. that of the longitudinal joints.

These requirements are not found in the Rules.

Paragraph 185 specifies that:

When shell plates exceed $\frac{9}{16}$ in. thickness in horizontal return-tubular boilers, the portion of the plates forming the laps of the circumferential joints, where exposed to the fire or products of combustion, shall be planed or milled down as shown in Fig. 8 to ½ in. in thickness, provided the requirement in Paragraph 184 is complied with.

There is no similar specification in the Rules.

Paragraph 186 gives 28,500 lb. per sq.in. as the ultimate tensile strength of a longitudinal joint welded by the forging process, with an allowable range of tensile strength of 47,000 to 55,000 lb. per sq.in. for steel plate. The Rules arrive at practically the same numerical result by stating the efficiencies allowed on forge-welded plates of tensile strength ranging from 52,000 to 56,000 lb.

Paragraph 190 states:

A horizontal return-tubular boiler on which a longitudinal lap joint is permitted shall not have a course over 12 ft. in length. With butt and double-strap construction, longitudinal joints of any length may be used provided the plates are tested transversely to the direction of rolling, which tests shall show the standards prescribed under the specifications of boiler-plate steel.

The Rules state that:

A horizontal return-tubular, vertical-tubular or locomotive-type boiler shall not have a continuous longitudinal joint over 12 ft. in length.

Paragraph 191 requires that:

Butt straps and the ends of shell plates forming the longitudinal joints shall be rolled or formed by pressure, not blows, to the proper curvature.

The corresponding requirement in the Rules is:

Butt straps shall be rolled or formed to the proper curvature on forms made for that purpose.

Paragraphs 192 and 193, covering calculations for the efficiency of ligaments, are the same as in the Rules except that the diameter of the tube holes is taken instead of the diameter of the tubes. The method of calculating the efficiency when the tube holes are drilled on a line diagonal with the axis of the shell or drum is different and a slightly lower result is obtained.

The requirements regarding domes are radically different, and so complete statements from both Code and Rules are given.

Paragraph 194 of the Code states:

The longitudinal joint of a dome 24 in. or over in diameter shall be of butt and double-strap construction, and its flange shall be double-riveted to the boiler shell when the maximum allowable working pressure exceeds 100 lb. per sq.in.

The longitudinal joint of a dome less than 24 in. diameter may be of the lap type, and its flange may be single-riveted to the boiler shell provided the maximum allowable working pressure on such a dome is computed with a factor of safety of not less than 8.

The dome may be located on the barrel or over the firebox on traction, portable or stationary boilers of the locomotive type up to and including 48 in. barrel diameter. For larger barrel diameters the dome shall be placed on the barrel.

The Rules state:

Steam domes shall be allowed only on a locomotive-type boiler and shall be located on the barrel of the boiler when the top of the barrel is as high as or higher than any other portion of the boiler shell, and on the wagon top only when the wagon top is higher than the barrel.

Steam domes shall be made of the same quality of material as the boiler shell.

When the pressure desired does not exceed 100 lb. per sq.in., the longitudinal joints of such steam domes may be of double-riveted lap construction when the diameter of the dome does not exceed 36 in., and the flange shall be double-riveted to the boiler shell.

When a pressure greater than 100 lb. is desired, the longitudinal joints of such steam domes shall be of butt and double-strap construction, and the flange shall be double-riveted to the boiler shell.

Heads of steam domes shall be convex.

When a hole larger than 4 in. diameter is required in a boiler which is constructed with a steam dome, it shall be reinforced to compensate for the metal removed.

At least two drain holes ¾ in. in diameter shall be located in the shell under a steam dome at the lowest point where water can collect, for the purpose of draining.

In Paragraph 195 of the Code, the formula for convex heads (pressure on the concave side) is

$$t = \frac{5.5 \times P \times L}{2 \times T.S.} + \frac{1}{8}$$

where

t = Thickness of plate, inches;
P = Maximum allowable working pressure, pounds per square inch;
TS = Tensile strength, pounds per square inch;
L = Radius to which head is dished, inches;

The Rules use a slightly different notation, but when reduced to the same is equivalent to

$$t = \frac{8.33 \times P \times L}{2 \times T.S.}$$

excepting that the thickness of plate shall not be less than ¼ in.

COMPARISON OF MASSACHUSETTS RULES AND A.S.M.E. CODE

February, 1916 Materials

Part of Boiler	Properties Considered	Massachusetts Rules		A.S.M.E. Code	
Shells, drums, butt-straps, heads, combustion chambers, furnaces or any plates that require staying or flanging	Brand	Openhearth firebox	Extra-soft steel	Openhearth firebox	Flange[2]
	Tensile strength	52,000–63,000	45,000–55,000	55,000–63,000	55,000–65,000
	Elongation in 8-in., not less than, per cent.	26	28[1]	$\frac{1,500,000}{\text{T.S.}}$	$\frac{1,500,000}{\text{T.S.}}$ [3]
	Phosphorus, not to exceed, per cent	Acid, 0.04, basic, 0.03	0.04	Acid, 0.04, basic, 0.035	0.05–0.04
	Sulphur, not to exceed, per cent	0.04	0.04	0.04	0.05
	Manganese, per cent	0.30 to 0.50	0.30 to 0.50	0.30 to 0.50	0.30 to 0.60
	Carbon			Plates $\frac{3}{4}$-in. thick and less 0.12 to 25 per cent.	
	Copper, not to exceed, per cent			0.05	
Rivets	Brand	Extra-soft steel		Boiler-rivet steel	Boiler-rivet iron
	Tensile strength	45,000–55,000		45,000–55,000	48,000–52,000
	Elongation in 8-in., not less than, per cent.	28		$\frac{1,500,000}{\text{T.S.}}$ but not exceed 30 per cent.	28
	Phosphorus, not to exceed, per cent	0.04		0.04	Min. yield point = 0.6 T.S.
	Sulphur, not to exceed, per cent	0.04		0.045	Reduction area 45 per cent. min.
	Manganese, per cent	0.30 to 0.50		0.30 to 0.50	
Braces—welded	Brand	Material not specified		Wrought iron	
	Tensile strength	6,000 lb. per sq.in. on mild steel and wrought iron		48,000	
	Yield point, lb. per sq.in.			25,000	
	Elongation in 8-in., not less than, per cent.			22 see permissible variations	
Braces—weldless	Brand	Material not specified		Wrough iron	Steel bars
	Tensile strength	62,000 certified test		48,000	55,000–65,000
	Yield point	$\frac{1}{2}$ T.S.		25,000	$\frac{1}{2}$ T.S.
	Elongation in 8-in., per cent	28		22	$\frac{1,500,000}{\text{T.S.}}$
	Phosphorus, not to exceed, per cent	Maximum allowable stress based on factor of safety, not less than 6.5			Acid, 0.06, basic, 0.04
	Sulphur, not to exceed, per cent				0.05
Stay-bolts	Brand	Same as for weldless braces		Stay-bolt iron	Stay-bolt steel
	Tensile strength			45,000–53,000	50,000–60,000
	Yield point			0.6 T.S.	0.5 T.S.
	Elongation in 8-in., min., per cent			30	$\frac{1,500,000}{\text{T.S.}}$
	Reduction of area, min., per cent			48	
	Phosphorus, not to exceed, per cent				0.04
	Sulphur, not to exceed, per cent				0.045
	Manganese, per cent				0.30 to 0.50
Tubes	Brand	Not specified—not required		Specified for lap welded	
	Material			Lap welded of O.H. steel or knobbled hammered char. iron. Seamless of O. H. steel	
	Carbon			0.08–0.18	
	Manganese			0.30–0.50	
	Phosphorus, not to exceed, per cent			0.04	
	Sulphur, not to exceed, per cent			0.045	
Cross-pipes, cross-boxes, headers, mud drums of boilers used for other than heating purposes, and for pressures exceeding 160 lb., and pressure parts of superheaters (unless attached to loco. type) manhole plates	Material	Wrought steel	Cast steel	Wrought steel Class B	Cast steel Hard / Medium / Soft
	Tensile strength	Not less than 50,000	50,000–60,000		80,000 / 70,000 / 60,000
	Yield point				36,000 / 31,500 / 27,000
	Elongation in 2 in., per cent		23		15 / 18 / 22
	Reduction in area, per cent		30		20 / 25 / 30
	Phosphorus, not to exceed, per cent		0.05		0.05
	Sulphur, not to exceed, per cent		0.05		0.05
Water-leg and door-frame rings of vertical fire-tube boilers 36 in. diameter or over and loco. and other types of boilers	Material	Wrought iron or steel or cast steel of not less than 50,000 lb. tensile strength and cast iron of not less than 18,000 tensile strength		Wrought iron or steel or cast steel, Class B, as above. Ogee construction allowed in place of same.[6]	
Cast-iron headers	Material	No specifications		Gray iron	
	Sulphur, not to exceed, per cent			0.08	
	Transverse test				2,500 lb.
	Tensile strength				18,000

[1] For each increase of $\frac{1}{8}$ in. in thickness above $\frac{3}{4}$ in. a deduction of 1 per cent., and for each decrease of $\frac{1}{16}$-in. thickness below $\frac{5}{16}$ in., a deduction of 2½ per cent. shall be made from the specified elongation.

[2] Steel plates for any part of a boiler, where firebox quality is not specified when under pressure, shall be of firebox or flange quality as designated in the specifications for boiler-plate steel.

[3] For material over $\frac{3}{4}$-in. in thickness a deduction of 0.5 from the percentages of elongation . . . shall be made for each increase of $\frac{1}{8}$ in. in thickness above $\frac{3}{4}$ in. to a minimum of 20 per cent. For material $\frac{1}{4}$ in. or under in thickness, the elongation shall be measured on a gage length of 24 times the thickness of the specimen.

[4] Pressure parts of superheaters, attached to boilers or separately fired, shall be of wrought or cast steel. Cast iron for superheat is prohibited (Amend. No. 24). Boiler and superheater mountings, such as nozzles, cross-pipes, steam pipes, fittings, valves and their bonnets shall be of wrought or cast steel when exposed to steam which is superheated over 80 deg. F.

[5] Cast iron shall not be used for boiler and superheater mountings, such as nozzles, connecting pipes, fittings, valves and their bonnets, for steam temperatures of over 450 deg. F.

[6] The ogee form of construction at the lower end of furnace sheet is prohibited in the Massachusetts rules.

On small diameters and pressures the Code gives slightly greater results and on large diameters and pressures smaller results than the Rules. The pressure allowed on concave heads in the Code is 60 per cent. of that allowed on convex heads. The Massachusetts formula for concave heads gives thicknesses 67 per cent. greater than those required for convex heads. Further differences are as follows:

Paragraph 196:

When dished heads are of less thickness than called for by Paragraph 195, they shall be stayed as flat surfaces, no allowance being made in such staying for the holding power due to the spherical form.

Paragraph 197:

The corner radius of an unstayed dished head measured on the concave side of the head shall not be less than 1½ in. or more than 4 in. and within these limits shall not be less than 3 per cent. of L in Paragraph 195.

The required corner radius required by the Rules is at least three times the thickness of the head. The Rules also specify that in a manhole opening the flange shall be turned inward.

The subject of Braced and Stayed Surfaces embraces more changes and additions than any other division and occupies about twelve pages of the Code. The general formula for braced and stayed flat surfaces and those which require staying as such is given in Paragraph 199, with several values of a constant to cover different conditions.

Paragraph 200 requires the outside end of stay-bolts on boilers having a grate exceeding 15 sq.ft. to be drilled

to a depth of ½ in. beyond the inside of the plate. The Rules require all stay-bolts to be drilled to a depth of ½ in. beyond the inside of the plate at both ends, with at least $\frac{3}{16}$-in. holes.

Paragraphs 202 and 203 contain requirements not found in the Rules as follows:

The ends of stays fitted with nuts shall not be exposed to the direct radiant heat of the fire.

The maximum spacing between centers of rivets attaching the crowfeet of braces to the braced surface, shall be determined by the formula in Par. 199, using 135 for the value of C.

The maximum spacing between the inner surface of the shell passing through the centers of the rivets attaching the crowfeet of braces to the head, shall be determined by the formula in Par. 199, using 160 for the value of C.

Paragraph 204 and Table 5 give values calculated from the formula in Paragraph 199 for maximum allowable pitch of screwed stay-bolts with ends riveted over. The values given in a corresponding table of the Rules were calculated from a different formula and are a little lower.

Other different requirements of this division are (Paragraph 205):

The distance from the edge of a stay-bolt hole to a straight line tangent to the edges of the rivet holes may be substituted for p for stay-bolts adjacent to the riveted edges bounding a stayed surface. When the edge of a stayed plate is flanged, p shall be measured from the inner surface of the flange, at about the line of rivets to the edge of the stay-bolts or to the projected edge of the stay-bolts.

The distance between the edges of the stay-bolt holes may be substituted for p for stay-bolts adjacent to a furnace door or other boiler fitting, tube hole, handhole or other opening.

The Rules state:

When the maximum allowable pitch is 5½ in. or less, the stay-bolts adjacent to a furnace door or other boiler fitting, handhole or other opening, may have an increased pitch of not over 1 in.

Provision is made in the Rules for an increase of pitch when hollow stay-bolts are used, and no such provision is found in the Code.

According to Paragraph 212 of the Code, all furnaces that require staying are stayed as flat surfaces, while the Rules give two separate tables and formulas—one, as mentioned, for flat surfaces and furnaces sheets over 38 in. diameter, and the other for furnaces 38 in. diameter and less; excepting corrugated furnaces or those strengthened by an Adamson ring or equivalent.

There appears to be a chance for misunderstanding between the provisions of Paragraph 212 and Paragraph 240 in the Code. The latter states that "a plain cylindrical furnace exceeding 38 in. diameter shall be stayed in accordance with the rules governing flat surfaces." No provision is made in the Code for staying furnaces under 38 in. diameter except as for flat surfaces. The intention evidently is to require a furnace over 38 in. diameter to be stayed as a flat surface regardless of its thickness or calculated strength as an unstayed structure.

Paragraphs 213 and 214, regarding staying segments of heads, are the same as the Rules, with the exception that gusset stays are specified as allowable.

Additional requirements of the Code not found in the Rules are:

In water-tube boilers the tubes of which are connected to drum heads, the area to be stayed shall be taken as the total area of the head less a 5-in. annular ring, measured from the inner circumference of the drum shell. When such drum heads are 30 in. or less in diameter and the tube plate is stiffened by flanged ribs or gussets, no stays need be used if a hydrostatic test to destruction of a boiler or unit section built in accordance with the construction shows that the factor of safety is at least 5.

In a fire-tube boiler stays shall be used in the tube sheets if the distances between the edges of the tube holes exceed the maximum pitch of stay-bolts given in Table 3. That part of the tube sheet which comes between the tubes and the shell need not be stayed when the distance from the inside of the shell to the outer surface of the tubes does not exceed that given by the formula in Paragraph 199, using 160 for the value of C.

The formula in Paragraph 217 for determining the net area to be stayed in a segment of a head is the same as the Rules, although in the Code formula different notation is used.

The table given in the appendix is identical to that in the Rules.

In the Rules a method and example are given for determining the net area to be stayed below the tubes in a horizontal-tubular boiler when a manhole is located under the tubes. The Code requires a deduction of 100 sq.in. from the total area requiring staying. This is practically the same as the result obtained by the method of calculation given in the Rules. The latter require that the center line of stays below the tubes at the front end shall not be below the center of the manhole, which is not required in the Code.

Allowable Stresses on Stay-bolts

Paragraphs 219 and 220 and Table 4 give a different method of determining the allowable stresses for stays and stay-bolts. The Code requirements (Table 4) of each are as follows:

Description of Stays	Stresses, Lb. per Sq.In. For Lengths Between Supports Not Exceeding 120 Diameters	Stresses, Lb. per Sq.In. For Lengths Between Supports Exceeding 120 Diameters
a. Unwelded stays less than 20 diameters long screwed through plates with ends riveted over	7,500	....
b. Unwelded stays and unwelded portions of welded stays, except as specified in line "a"	9,500	8,500
c. Welded portions of stays	6,000	6,000

When stay rods are screwed through the sheets and riveted over, they shall be supported at intervals not exceeding 6 ft. In boilers without manholes, stay rods over 6 ft. in length may be screwed through the sheets and fitted with nuts and washers on the outside.

The maximum allowable stress per square inch net cross-sectional area of stays and stay-bolts shall be as given in Table 4. The length of stays between supports shall be measured from the inner faces of the stayed plates. The stresses are based on tension only. For computing stresses in diagonal stays see Paragraphs 221 and 222.

On the stresses on stays and stay-bolts the Massachusetts Rules state:

The maximum allowable stress per square inch net cross-sectional area of stays and stay-bolts shall be as follows:

Material and Type	Size Up To and Including 1¼ In. Diameter or Equivalent Area, Lb.	Size Over 1¼ In. Diameter or Equivalent Area, Lb.
Weldless mild-steel head-to-head or through stays	8,000	9,000
Weldless mild-steel diagonal or crowfoot stays	7,500	8,000
Weldless wrought-iron head-to-head or through stays	7,000	7,500
Weldless wrought-iron diagonal or crowfoot stays	6,500	7,000
Welded mild-steel or wrought-iron stays	6,000	6,000
Mild-steel or wrought-iron stay-bolts	6,500	7,000

When a greater allowable stress on stays and stay-bolts is required than that allowed by the foregoing, the material shall conform to the properties given in the table showing materials to be used for the various parts of boilers.

Stay rods shall not exceed 3 ft. in length when screwed through the sheets and riveted over. Stay rods longer than 3 ft., such as are used for bracing the segment of a circle, shall have not less than 0.7854 sq.in. cross-sectional area.

The remainder of the article will appear in next week's issue.

Records at the Blackstone

By W. A. Eberman

SYNOPSIS—An outline of plant equipment and operating conditions. Sample records, blank forms and curves showing the monthly variation in the principal operating data and expense items.

In the following article will be described the system employed by the engineering department of the Blackstone Hotel, Chicago. To make it better understood it will be necessary to give an idea of the hotel, its power plant and its organization and policy.

The Blackstone building covers a plot 82x172 ft. and rises 26 floors above the basement, which is 28 ft. below the street level. Above the basement, where the engine room, storeroom and wine cellar are located, are the grillroom and barber shop. On the level above are the lobby and restaurants. Over these are the ballroom and banquet hall, kitchen and private office. The next floor is given up to private dining rooms, and above this 16 floors are devoted to guest rooms, 400 in all. On the next floor is a fully equipped laundry with a capacity of 35,000 pieces a day. On the top of the building is the elevator machinery and an artist's studio.

To the engineering department is given the entire upkeep of the building proper, besides the operation of the power plant. All building repairs, electrical work, plumbing, steam fitting, carpenter and cabinet work, painting and decorating, kitchen and laundry upkeep are under the supervision of the chief engineer. All complaints and requests for work to be done come to his office, where they are given to the proper workmen, who take care of the trouble.

Large Working Force Required

To handle this work requires a crew varying from 50 to 60 men, who are naturally divided between a number of subdepartments. Each force is under a working foreman responsible for the work of his men and accountable only to the engineer.

The engine room is on the lowest level, 28 ft. below the street, and covers a space 148x65 ft., with 14 ft. headroom. There are four 250-hp. water-tube boilers equipped with chain-grate stokers, the latter being served with coal from overhead bunkers that are filled by a traveling motor-driven weigh hopper. All coal is weighed as fired, and these weights find a place on the record sheets.

The feed-water, which is supplied by two duplex pumps regularly and by the house pumps in an emergency, must pass through a venturi meter, which is calibrated at intervals by weighing the water actually passing through it for 24 hr. To insure accuracy this check on the meter is important. Feed water is heated to 160 deg. in a primary heater made by putting coils in the receiving tank, and is then passed through a closed heater. The coal burned is No. 4 washed nut costing $2.90 to $3.10 per ton. The ashes from the boilers are handled by a pneumatic system which elevates them to a tank high enough above the alley in the rear of the building for a wagon to drive under and load. The total steam generated is around 144,000,000 lb. yearly.

The generating plant consists of two 200-kw. and one 300-kw. three-wire direct-current generators driven by four-valve engines. The voltage is 110 for lighting and 220 for power. There is a double system of busbars on the switchboard, so that the lighting and power can be separated if the load fluctuation causes a flickering in the lights. This trouble has never been experienced, so the machines are rarely separated. The maximum observed load has been about 1,600 amp., neglecting the swings due to the elevators. The average daily output is about 4,000 kw.-hr., the maximum having been 5,500 kw.-hr. The connected load is approximately 15,000 incandescent lamps averaging 40 watts and 80 motors aggregating 650 hp. The load factor averages about 31 per cent.

The refrigerating work consists of cooling brine for the ice tanks of 7½ tons' capacity, of circulating brine through 66 refrigerators widely scattered from the basement level to the top service pantry 20 floors above, and in summer the cooling of air for the grillroom, lobby, ballroom and restaurant.

FIG. 1. PERCENTAGE EACH SUBDIVISION BEARS OF TOTAL COST OF MECHANICAL DEPARTMENT

The brine cooling is done by a 55-ton carbon-dioxide machine driven by a Corliss engine. The ice is frozen by a raw-water system. There are 46 cans with a capacity of 350 lb. each, and as freezing is done with brine at zero, it takes but 24 hr. to harvest the ice. The brine is compounded, passing first through the tank and then through the refrigerators. Another machine, nominally rated at 100 tons, is used for the room cooling. About 60,000 cu.ft. of air per minute is cooled from whatever the outside temperature may be to 60 deg. as it leaves the cooler.

Direct expansion is employed in the coolers, the air passing through banks of coils over which sheets of water flow. In these same cooling units are embodied the air

Date_____ **ENGINE ROOM**

SWITCHBOARD — REFRIGE

	POWER						LIGHTING						BRINE COOLING			AIR COOLING		
	Engines	Volts	AMPERES Steady	AMPERES Swings	Wat[illegible]r	TOTAL AMPERES LIGHT & POWER +	TOTAL AMPERES LIGHT & POWER −	Engines	Volts	AMPERES +	AMPERES −	WATTMETERS +	WATTMETERS −	Engines	PRESSURES Head	PRESSURES Back	Engines	PRESSURES Head	PRESSURES Back
12:30 A. M.																			
1:00																			
1:30																			
2:00																			
2:30																			
11:00																			
11:30 P. M.																			
12:00																			
Enter Last Readings of Previous Day																			
Total																			
Average																			

DATE_____

FIG. 2. THE ENGINE-ROOM DAILY RECORD IS FILLED OUT BY THE OPERATING ENGINEERS AND SUBMITTED

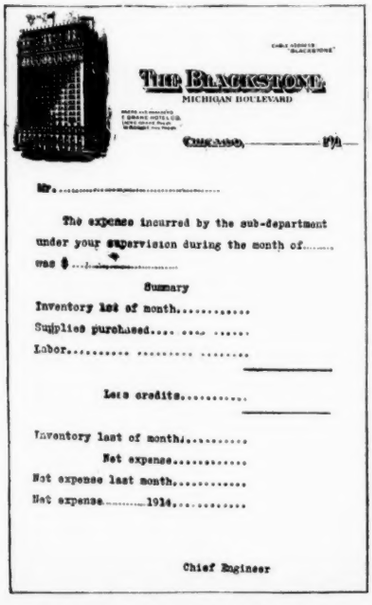
washers and the indirect heating system for winter use. As the air cooling does not call for low temperatures, high back pressures are permissible and the machine may be run above rating; in fact, the work requires about 130 tons of refrigeration on warm days. Double-pipe condensers and brine coolers are used. The brine-handling pumps are steam- and motor-driven centrifugals.

The water service is divided into three systems, the low-pressure being tapped to the city mains, which supply the street level and below. The medium-pressure system serves the first nine floors above the street, and the high-pressure system all floors from the tenth to the roof. The pumps are all compounds and connected so that any one may be used on any service or all four may be thrown into the fire line. About 300,000 gal. of water is used daily, and 25 per cent. of this is heated for the rooms, laundry, kitchen, etc. There are ten elevators, six being electric and four of the hydraulic plunger type. The four cars in the front of the hotel, devoted to the guests, are of the one-to-one overhead traction type, while the two service cars are geared. These six cars average 55,000 mi. a year, or 25 mi. a day each.

The kitchen is on the second level above the street. Gas is used for fuel in the ranges and boilers, and coke is used in the ovens. Much of the cooking is done with live steam. Dishes and silverware are kept warm in live-steam heated dish warmers.

Exhaust steam at atmospheric pressure under thermostatic control heats the building. There is approximately 40,000 sq.ft. of direct radiation and 15,000 sq.ft. of indirect surface in the hotel and theater building, the latter being heated and lighted by the power plant.

It became apparent shortly after the opening of the hotel in 1910 that some system of records would have to be devised that would make it possible to keep track of what was going on and to divide the expense between



THE BLACKSTONE
MICHIGAN BOULEVARD

CHICAGO, _____ 191_

Mr. _____

The expense incurred by the sub-department under your supervision during the month of_____ was $_____

Summary

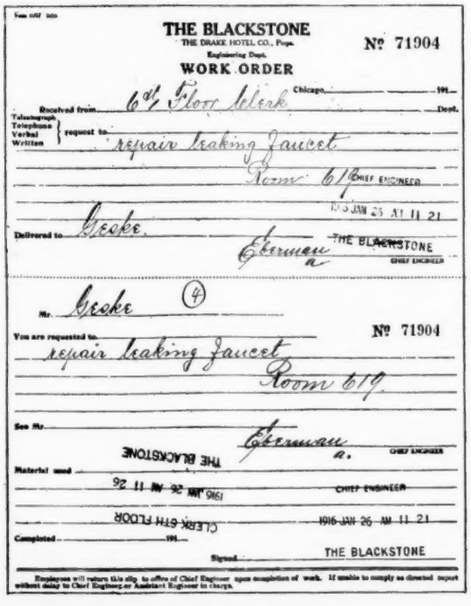
Inventory last of month.....
Supplies purchased.....
Labor.....

Less credits.....

Inventory last of month.....
Net expense.....
Net expense last month.....
Net expense.....1914.....

Chief Engineer

FIG. 3. MONTHLY SUMMARY



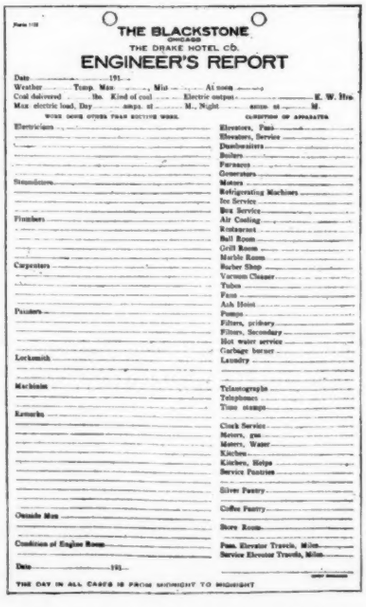
THE BLACKSTONE
THE DRAKE HOTEL CO., Props.
Engineering Dept.
WORK ORDER
№ 71904

Received from 6th Floor Clerk Chicago, _____ 191_ Dept.
Telautograph / Telephone / Verbal / Written request to repair leaking faucet
Room 619
CHIEF ENGINEER
1916 JAN 25 AM 11 21
Delivered to Greske
Ehrman
THE BLACKSTONE
CHIEF ENGINEER

Mr. Greske (4)
№ 71904
You are requested to repair leaking faucet Room 619.
See Mr. Ehrman
THE BLACKSTONE
CHIEF ENGINEER
Material used
1916 JAN 26 AM 11 26
CHIEF ENGINEER
CLERK 6TH FLOOR
1916 JAN 26 AM 11 21
Completed _____ 191_
Signed THE BLACKSTONE

Engineer will return this slip to office of Chief Engineer upon completion of work. If unable to comply as directed report without delay to Chief Engineer or Assistant Engineer in charge.

FIG. 4. WORK ORDER



THE BLACKSTONE
CHICAGO
THE DRAKE HOTEL CO.
ENGINEER'S REPORT

Date _____ 191_
Weather _____ Temp. Max. _____, Min. _____ At noon _____
Coal delivered _____ lbs. Kind of coal _____ Electric output _____ K. W. Hrs.
Max. electric load, Day _____ amps. at _____ M., Night _____ amps. at _____ M.

WORK DONE OTHER THAN ELECTRIC WORK	DESCRIPTION OF APPARATUS
Electricians	Elevators, Pass.
	Elevators, Service
	Dumbwaiters
	Boilers
	Furnaces
Stationfirers	Generators
	Motors
	Refrigerating Machines
	Ice Service
Plumbers	Bra Service
	Air Cooling
	Restaurant
	Ball Room
	Grill Room
Carpenters	Marble Room
	Barber Shop
	Vacuum Cleaner
	Tubes
	Fans
	Ash Hoist
Painters	Pumps
	Filters, primary
	Filters, Secondary
	Hot water service
Locksmith	Garbage burner
	Laundry
Machinist	Telautographs
	Telephones
Kenwrks	Time stamps
	Clock Service
	Meters, gas
	Meters, Water
	Kitchen
	Kitchen, Helps
	Service Pantries
	Silver Pantry
Outside Men	Coffee Pantry
	Store Room
Condition of Engine Room	Pass. Elevator Travels, Miles
	Service Elevator Travels, Miles

Date _____ 191_
THE DAY IN ALL CASES IS FROM MIDNIGHT TO MIDNIGHT

FIG. 5. ENGINEER'S REPORT

DAILY RECORD

RATION

TEMPERATURES oF

BRINE COOLER		WATER			ICE BRINE	
Warm	Cold	City	CONDENSER Entering	CONDENSER Leaving	Entering	Leaving

HEATING

Pump	Pressure	Vacuum	TEMPERATURE				
			Outside Air	Dining Room	Ball Room	Marble Room	Grill Room

WATER SUPPLY

PRESSURES					TEMPERATUTES				
PUMPS		SYSTEM			HOT WATER		FEED WATER	DRINKING	
H. P.	M. P.	H. P.	M. P.	City	H. P.	M. P.		Entering	Leaving

Chief Engineer

METERS

WATER

	TOP	BOTTOM	WINE ROOM
12 A. M.			
Previous 12 A. M.			
Total cu. ft.			
Grand Total			

ICE MACHINE WATER

	INLET	OVERFLOW
12 A. M.		
Previous 12 A. M.		
Total cu. ft		
" lbs.		

Ice harvested, lbs

Brine circulated, lbs.

Temperature Difference oF

Tonnage, Ice

Time of starting freeze No. 1

Time of stopping freeze No. 1

Time of starting freeze No. 2

Time of stopping freeze No. 2

Total Tonnage, Ice and Boxes

Grand Total Tonnage

BOILER ROOM

SHIFT	WATER FED LBS	COAL LOKNED	EVAPORATION
12-8			
8-4			
4-12			
Total			

Coal burned, Incinerator lbs

GAS

	HUBBARD	MICH.	BELTS
12 A. M.			
Previous 12 A. M.			
Total			
Grand Total			

Exhaust Steam on Heating System

M To M.

Live Steam on Heating System

M To M.

Air Refrigeration on M To M

M. To M

TO THE ENGINEER'S OFFICE TO BE WORKED UP FOR THE MONTHLY REPORT

the different branches of work. The difficulty was to decide just what was wanted and what could be dispensed with. A daily record sheet was made out covering the essential points of operation in the engine room. The records cover mainly the production end, leaving the distribution of costs among the various departments in the hotel to the comptroller's office. There are not instruments or meters enough to determine how much service each department is using, but strict account of the totals is kept.

The essential facts to be ascertained and recorded are how much steam is generated each day on each shift and the amount of coal burned to generate it. Places are provided for these data, and the reason for any noticeable variation from the average can be looked into at once. This puts the boilers under test conditions at all times, instead of running tests at long intervals, and tends toward efficiency. For any increase in the steam consumption, it is necessary to find out how much current was generated, how much water was used, how much refrigeration, etc. Spaces are included for all these and for the data necessary to arrive at the totals. For example, to secure the figures on the refrigeration output, it is necessary to know how much water was circulated through the condenser and the difference in temperature of the water entering and leaving. These known, a simple calculation gives the answer.

It is desirable to know whether the increase in current consumption is due to increased power load, caused perhaps by an extra heavy elevator service, or by more lights than usual. The elevator mileage, by the way, is a good index of the number of guests being entertained. The elevators all have mileage recorders, and a daily record is kept of the travel. This does not appear on the main sheets, but is kept on the card-index system.

The daily record sheet, Fig. 2, is filled out by the operating crew and brought to the engineer's office, where it is worked up and the desired totals, averages, maximums and minimums are entered on the monthly record, Fig. 6. These monthly sheets are filed in a glass-front wall case with the last month's sheet in view.

Close track is kept of supplies purchased. Each order goes through a regular routine. Everything that is bought for the engine room or the other subdepartments under the engineer's supervision is purchased by him and ordered on a printed order blank. All bills for the material come to the engineer's office and, after being checked, are approved by him. The bills are then entered in a loose-leaf ledger and on the card index. Each of the subdepartments or divisions of expense is given a card for the current month. On it is entered every item of expense, including labor that may properly be charged to that department. At the end of the month these cards are totaled and the totals of the supplies and labor, with the credits, are put on another card for that month, which when totaled, gives the grand total expense for all departments. On the back of the cards are entered all large items or extraordinary expenses that would account for any noticeable increase in the cost of operating any subdepartment. It is from these cards that the expense curves are plotted; the figures for the yearly report are totals of the monthly cards.

MONTH _____ 191__ ENGINE ROOM

SWITCHBOARD — REFRIGERATION

Date	POWER: Engines Hours 1	2	3	Aver Volts	Amperes: Minimum Steady	Maximum Steady	Maximum Swing	K.W hours	LIGHTING: Amperes: Maximum	Minimum	Maximum	Minimum	K.W hours	Total Amperes		Total K.W hours	REFRIGERATION: Engines 1	2	Pressures Atms 1 Head	1 Back	2 Head	2 Back	Temperatures °F: Brine Cooler Warm	Brine Cooler Cold	Ice Brine Enter	Ice Brine Leav	City Water	Condenser Enter	Condenser Leav	Ice Harvested
1																													
2																													
3																													
4																													
31																													
Total																													
Average																													

FIG. 6. ENGINE-ROOM MONTHLY REPORT CONTAINS THE TOTALS.

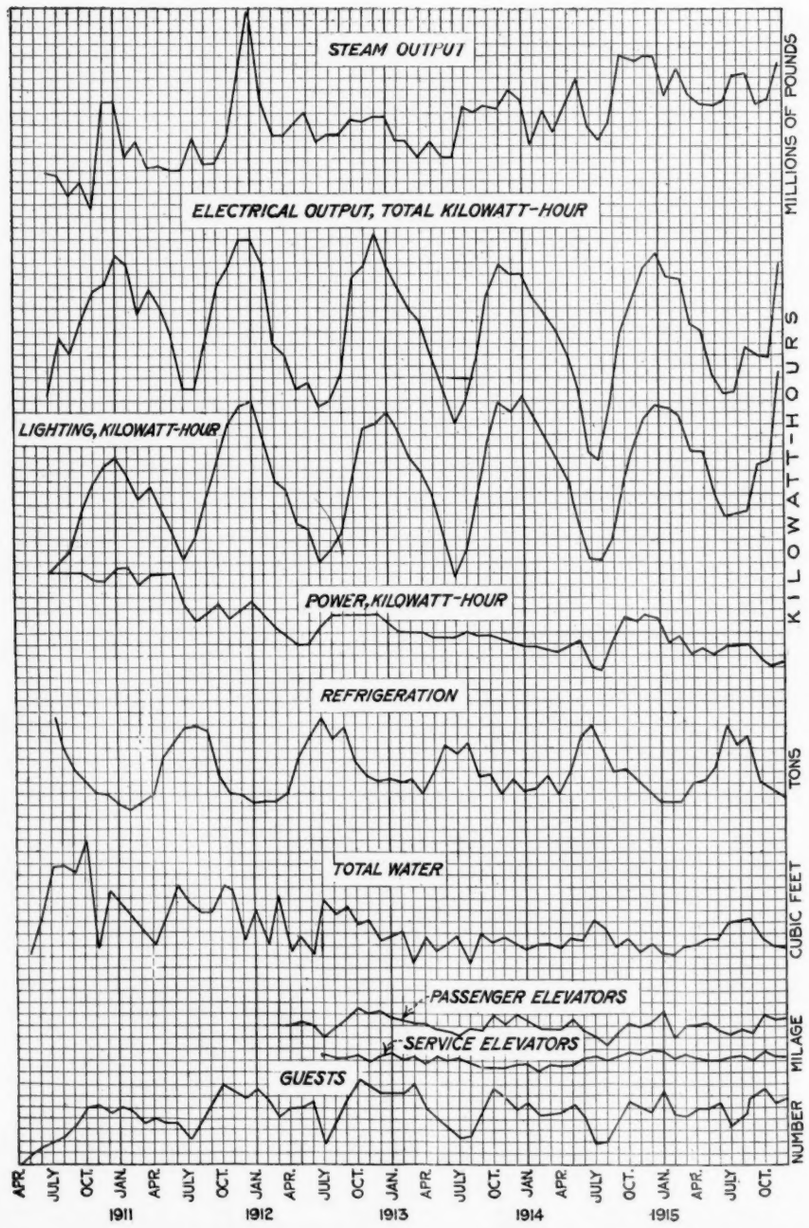


FIG. 7. SOME OF THE MORE IMPORTANT CURVES, INCLUDING STEAM AND KILOWATT OUTPUT

The card system is handled without having to put on any help other than that required without it. One advantage of a system of records such as outlined is that the men that actually operate the plant can refer to them and tell what they are doing. In addition a monthly summary, which includes similar figures of the previous month, is issued to the head of each subdepartment; see Fig. 3.

In the transaction of its business the department uses a number of form blanks which make it possible to keep close track of the work and afford a means of settling arguments as to whether certain work has been done and by whom it was done.

For instance, a complaint about plumbing trouble in one of the rooms would be entered on the form Fig. 4. The top half is kept in the engineer's office, and the lower part is given to the workman who goes to the room. When the job is finished, the floor clerk puts an O.K. on the work by time-stamping the slip on the line marked "completed." The slip is then returned and with the top part is filed. By the use of this form it is possible to tell at once, by looking at the unmatched top parts, just what work is still unfinished. The forms give a complete history of the work in question and settle once for all just when it was done. The time element is of more importance in this hotel than in an office building for in a hotel immediate service is expected, and it often happens that a complaint will be made and a few minutes later another call will be put in with the statement that the guest had been waiting for an hour. If there is a second request for service it is referred to the management.

MONTHLY RECORD

WATER		TOTAL	HEATING								WATER SERVICE									BOILER ROOM									
Lbs. Circulated	Lbs. to Overflow	Tonnage	PUMPS 1	2	3	Av. Pressure	Av. Vacuum	AVERAGE TEMPERATURES Outside Air	Ball Room	Dining Room	Marble Room	AVERAGE PRESSURES City	High	Radial	City	AVERAGE TEMPERATURE S° Hot Water H. P.	M. P.	Drinking S.	R.	TOTAL Water	BOILERS 1	2	3	4	Coal Burned Lbs.	Water Fed Lbs.	H. P. Developed	Temp. Feed°	Water per lb. Coal	Coal per K. W. hr.	

Chief Engineer

AVERAGES, MAXIMUMS AND MINIMUMS WORKED UP FROM THE DAILY LOG

The time as stamped on the slip is accepted as final in determining whether there has been any unnecessary delay.

The management requires a report each day, covering roughly the work done by the engineering department. This report was originally kept in the conventional logbook. Later the printed form shown in Fig. 5 was devised. This is made out in duplicate, one copy being sent to the management and the other placed in the files. Several other forms are used, including coal-weight blanks, gas reports, etc.

These records serve their purpose, but to make a comparison of one period with another means going over a mass of figures and it is often difficult to make them clear to others, especially to the layman. To simplify this, monthly results most often wanted for reference are plotted on cross-section paper in a series of curves that show at a glance whether the consumption, output or expense at one period is higher or lower than normal. The curves make plain the connections between changing conditions and varying output. After plotting them for a few years, a lot of information is secured as to what may be expected in certain seasons of the year, and any great departure from previous seasons stands out prominently. In this plant curves are plotted not only of engine-room performances, but of costs in the various subdepartments, these costs being subdivided between labor and material. Some of the more important curves are reproduced in Figs. 7 and 8. The curves kept on file are of steam output, total electric load, current for lighting and for power, refrigeration load, water handled, temperature averages and

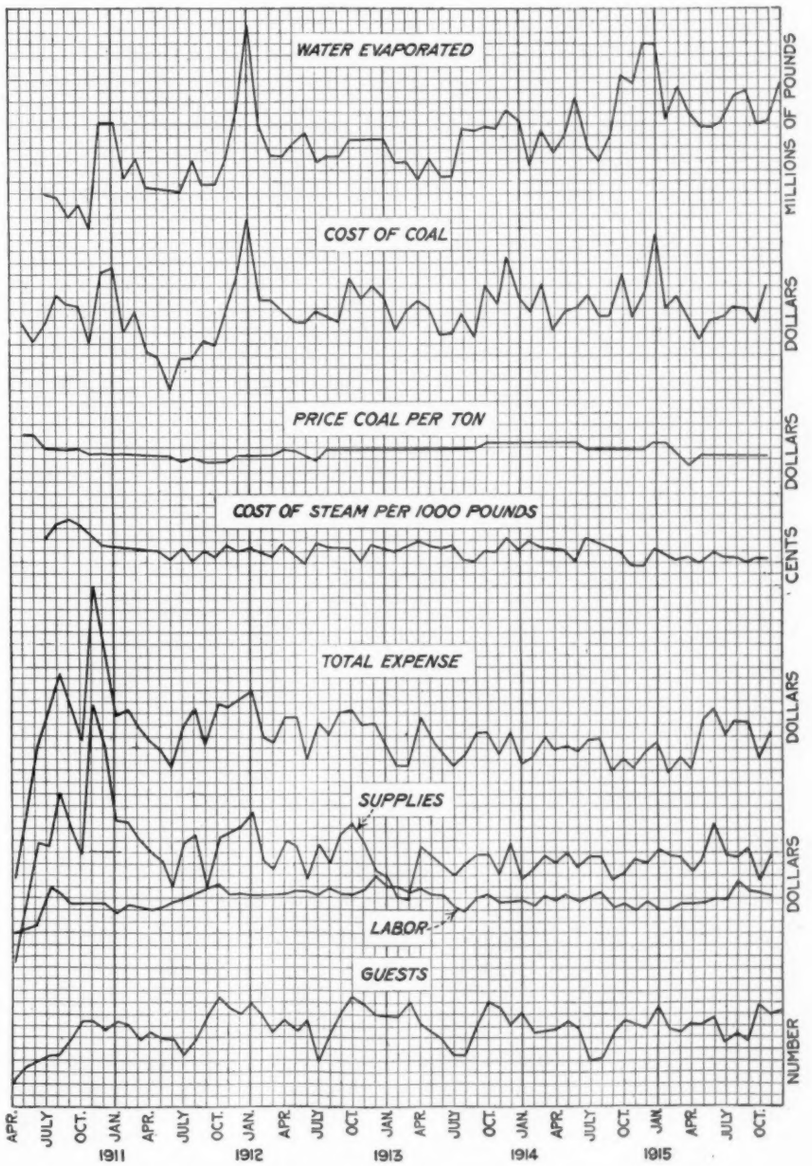


FIG. 8. COST CURVES AND TOTAL OPERATING EXPENSES

These curves show the cost of water evaporated, cost of coal and the price per ton, also the cost of steam per 1,000 lb. The total expense curve is shown, also those for supplies, labor and the number of guests

elevator mileage. Other charts take care of the expense incurred and show the total expense, total labor and supplies. The expenses of subdepartments in which labor and supplies are large and subject to considerable variation are charted, and another chart divides the cost of labor and material between the mechanical division and the engine room. To the mechanical division are applied expenses other than for the actual operation of the engine-room machinery.

Convenience of the Charts

To show the convenience of these charts, suppose the engineer was asked why the expense for a given month was higher than the corresponding month of a previous year. Reference to the charts will show that the total expense is higher and that the increase occurs in both the mechanical division and in the engine room. It is shown that the mechanical-expense increase is due to more work by the painting department, which has a larger force working, and reference to the card index shows that a large stock of material was bought during that month. The engine-room expense is higher, but no increase in labor is shown, so it must be due to output in excess of that of the previous month in question. The steam curve shows an increase, and as the coal is up in the same ratio, it is evident that the efficiency has not been lowered. The electrical load is higher, and the curves show whether or not it is due to extra lighting or power. Assume that they are both high. Part of the power consumption can be accounted for by referring to the elevator mileage curve, which shows a decided rise. The increase of lighting is due to more people being served, which is indicated both by the elevator mileage—a good index—and the curve giving the number of people served. A greater water consumption is also evident. This is to be expected with more people using it in their rooms, more linen to be washed, more food to be prepared and cooked and more dishes to be washed, all of which takes water.

Comparison of Current Consumption

The question is raised, "Why is it that in the summer months, with current consumption at its lowest, the steam does not come down in proportion?" The answer is found by looking at the curve of refrigeration, where it is seen that the output was at its greatest. The reason for this is found by looking up the weather curve showing the average mean temperature for the month, which in this case is high, and the necessity for more ice and box cooling and more and cooler air for the restaurant, lobby, etc. In fact, the whole story is plotted out so that anyone can easily read it. It is worth the trouble.

The curve charts are fastened to thin boards, 18x24 in., which slide in grooves in a cabinet made for them. Both sides of these boards can be used, so that 22 sheets can be handled. Fig. 1 is a chart prepared to show at a glance the percentage each subdivision of the mechanical department bears to the total expense for labor and supplies.

The foregoing covers pretty well what must be known to run the plant with a fair degree of efficiency, and while there is much more that could be kept in the way of records and subdivision of expense, a stop had to be made somewhere, and it was made before the system became a burden.

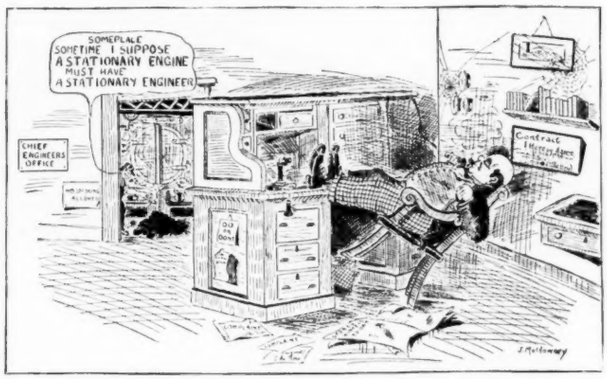
JUST FOR FUN

Porous Cold-Water Pipe

The contractor, who was to cover a cold-water pipe with anti-sweat pipe covering to prevent dripping caused by moisture in the air, that at times gathered on the pipe, convinced those "higher up" that at least one foot should separate the steam and water pipe or he would not guarantee results, as he was convinced that the cold-water pipe was porous and the hot pipe caused it to sweat.

It was a waste of time to argue the question. I merely said, "If it gives any trouble, I'll change it."

"Well, you'll change it mighty soon," was the reply, but I didn't.—Charles Haeusser, Albany, N. Y.



A "STATIONARY" ENGINEER

Very Much on Himself

I had always lived and worked in towns having 24-hr. electric service. About two years ago I went to a small town to run the station where service was supplied from dusk to midnight only. After my first run I went to the house where I was rooming and tried to turn on the light, but "nothing doing." I tried a new lamp in the socket and with a match for a torch hunted 10 min. for a defect in the wiring—and that after I had just shut down the plant myself. Can you beat it?—A. C. Griffin, Dixon, Ill.

Ma Didn't "Bust"

Down in Mississippi a youth graduated from the "cotton patch" to a small sawmill near-by. One day the fireman was ill, and as the youth could operate the injector he was put to work firing the old boiler that was never allowed to carry more than 80 lb. pressure. Later on the mill foreman, noticing extra power at the saw, went to look at the steam gage that was standing at 100 lb. and excitedly exclaimed, "What are you doing? Don't you know you will bust that old boiler with all that steam on it?" But the youth calmly replied, "No it won't. When Ma had typhoid fever, it went to 104 on her and she didn't bust."—M. M. Baxter, Agricultural College, Miss.

Editorials

Cultivating Clear Thinking

Clear thinking upon engineering problems is essential to their prompt solution. Loose, or "muddy," thinking, as it well-called, handicaps efficient work, leads the engineer into byways and pitfalls and often injures his prestige with his superiors.

Suppose an engineer is confronted with the problem of recommending a new feed-pump installation. Whether the centrifugal or the reciprocating type shall be purchesed, whether the units shall be steam-driven or electrically operated and the comparative merits and costs of different makes will all have to be considered. A "muddy" thinker will begin to accumulate data about various pumps, but is liable to assemble it in rather illogical if not incoherent form, and very likely will fail to obtain sufficiently complete information to enable quick and close comparisons to be made by his superior, for all the competitive equipment. The engineer may be a first-class operating man, resourceful in emergencies and blessed with constructive ability, but unless he thoroughly appreciates the scope of information required to determine the fitness of one or more makes for the service in hand and cultivates the habit of putting down his information in logical order, reasoning in a steady progression, his task is bound to be difficult.

In comparing various makes of apparatus, it is easy to lose track of main issues and to follow collateral lines of inquiry, after which the confusing of information, or at least its presentation in a complicated way, easily comes about. An engineer who has learned by experience or by rigorous training to think in a straight line and to follow essentials in inquiries, giving due weight to side issues but never losing sight of the main route to be traversed, will avoid cumbering his memorandum with unessential points and will seek to present all the vital factors in a way which will facilitate rapid balacing of one against another. Half the battle is won when a man knows what information he wants and proceeds to secure it all at the outset instead of delaying his work later by going after further data the need for which should have been foreseen.

Other examples of hazy thinking frequently occur in the office of the superintendent or plant owner, when perchance an engineer may be subjected to a running fire of unexpected inquiries, possibly in the presence of outsiders. In such situations it helps considerably to stand firmly on the fact that there is no disgrace in being unable to make categorical replies to questions properly requiring time for answering. If an engineer is sound in his position when he does speak, has good judgment and yet insists on being given an opportunity to secure his material as needed in responses to inquiries, he will suffer little in the estimation of his employer, but if a man beats about the bush, hazards guesses about points that can be verified or partly checked often within a few moments by telephone or conversation with subordinates or by producing actual records, he is apt to lose ground in the eyes of his superior that is very hard to recover.

So far as an engineer can answer questions on the spot, well and good, but few men there are indeed who do not require an appreciable time in which to master new propositions and conditions when suddenly presented. Given the necessary raw materials on which to work, the clear-thinking habit of mind can be cultivated, which is one of the most encouraging things for the struggling engineer to realize.

The Temptation to "Let Up"

It is natural for a power-plant engineer who has achieved some success and reputation to exert himself less than before. He is prone to feel that some of the burdensome details of the past can be left to others and that he can begin to enjoy the things that were formerly put aside in the interest of personal advancement. In every walk of life a few years of success while a man is at the height of his powers often prove a big temptation to "let up" on the pace, with the result that he gravitates to a mediocre position without distinction as an original worker and with ever-increasing wonderment why promotion passed him by when for a time things were going so well.

This inclination to slip back into easy-going habits is one of the greatest enemies of the human race. Who has not found it increasingly difficult to persist in a given regimen while becoming consciously stronger after an illness, and who is wholly proof from the delusions of success and wise enough to maintain his driving power in the face of diminishing necessity? Certainly the man who has learned to look upon temporary success merely as the vantage ground for still higher endeavor and who sharpens the edge of his industry on such opportunities is the exception; but he is the exception envied by his fellows the world over.

Here is an engineer, let us say, whose study of draft conditions in his station has resulted in a substantial reduction in operating cost. The management has promoted him to be assistant chief, with increased responsibilities and considerable authority over the rest of the staff. For him, a good deal of the actual manipulation of apparatus and tools may be no longer necessary. What does "letting up" mean in his case? Well, first of all, it means that he will have a greater measure of freedom in his work, and in some plants the privilege of getting outside oftener in connection with the purchase of supplies of at least a minor character or other work when the chief himself is otherwise occupied. Where he went to the toolroom in person and "tackled" a job with his own hands, it may well be that now he is in a position to oversee its accomplishment by others, with more or less time to spend as he may elect.

Upon the way in which such a man employs his time and energy in his new position depends his entire future. If he settles back contented with what he has already

accomplished and puts in an hour or so a week in the daytime downtown at the movies, acquires the chair-warming habit at the station and gradually takes things more leisurely, the result is sure to be different from what he anticipated. On the other hand, if he maintains his interest in every detail of station work, keeps a close watch upon details for abnormal tendencies and devotes himself with all his powers to present and future problems, the outcome cannot be in doubt.

Ceaseless industry, with a reasonable amount of relaxation at proper times, is the one great remedy against deterioration through dwelling upon past successes, and although higher position brings greater burdens, it usually affords greater opportunities to the man who can look success in the face without losing his driving power—opportunities that beckon to the Twentieth Century engineer with a compulsion that the man with ambition cannot and will not resist.

Electrical Undertakings in Great Britain

W. W. Lackie, in his presidential address to the Institution of Engineers and Shipbuilders in Scotland, said that 18 years ago, in Great Britain, there were only 38 electricity-supply companies, with a capital of £6,000,000, and 33 municipalities owned electricity works with a capital of £2,000,000. Eighteen years ago there were 17 privately owned electric-traction schemes in this country, with a capital of £7,000,000. This gives a total of 88 concerns, with a capital of £15,000,000.

Today there are 276 companies, owning electricity works having a capital of £61,000,000; 328 municipalities own electricity works with a capital of £52,000,000; besides 172 traction companies with a capital of £183,000,000; and 175 municipalities have electrically operated tramway systems, with a capital of £53,000,000. These figures represent a total of 951 concerns and a capital of £349,000,000.

Getting Together at Hearings

If ever a united front counts, it is at a legislative-committee hearing in which some bill to advance the interests of engineers is on the calendar. In a recent hearing at which the committee listened most hospitably to everyone who had anything pertinent to say, one group of engineers favored a bill and another group diametrically opposed it, which they had an entire right to do as good citizens—but the resulting effect on the committee was what might have been expected. There is a natural antipathy against new legislation unless its real necessity can be shown, and the appearance of two sets of able representatives of a single profession on opposite sides of a proposition is about the best possible prescription for killing a measure "the first crack out of the box" and apart from its real merits or demerits.

It is too much to expect, and it is no doubt undesirable, for engineers to think alike on even a majority of quasi public questions affecting their work; but while admitting this, it is worth while emphasizing that the best place to thrash over diversified ideas is outside the committee room and the best time is before the hearing occurs. Many engineers have never attended a committee hearing and fail to realize the importance of vigorously presenting a clean-cut case of facts when they want something from the legislature of their particular state. Even union representatives are not always in agreement as to bills and policies, and where representatives of hundreds and perhaps thousands of engineers and firemen go before a committee and disclose a split, it is small wonder if a bill gets an adverse report, even if the split is over some minor phase of the matter at issue.

By ascertaining the position of all interested parties far enough in advance of a hearing to enable differences to be thrashed out and perhaps compromised in the interests of all concerned, a good deal more can be accomplished than by hit-or-miss independent propaganda without any general preliminary understanding of the practicable solutions of the problem.

Wouldn't it be nice if wrenches never slipped?

How much more does it cost to make a gallon of gasoline now than it did six months ago?

Who gets the difference in the selling price?

"There was a day when Rhode Island engineers were among the best in the country," said one of them at the recent hearing in Providence on the engineers' license bill. Yes; and they are yet, Mr. Weaton.

The pallograph is an instrument which simultaneously records vertical and horizontal transverse vibrations. While primarily designed for use aboard ship, it may be used to trace vibrations or oscillations of any character to their source. We can recall instances in connection with vibrating buildings, piping systems and engines and boilers where a pallograph would have earned a good dividend on its price.

The New Jersey legislature by an overwhelming vote passed over the governor's veto a bill specifying penalties for violation of the engineers' license law and granting a well-deserved increase in the salaries of the examiners. Jersey legislation can be as swift as the proverbial Jersey justice. With at least eight bills passed over his veto in a single day, Governor Fielder should have a suspicion that this is so.

After listening to his interesting résumé of the stormy history of the Board of Boiler Rules of Massachusetts as he related it recently before the American Institute of Steam Boiler Inspectors, Joseph McNeil, former chairman of the board, though he said nothing about the Code, makes one appreciate that the success it will have after its adoption by any state depends very considerably on the wisdom and diplomacy of the body authorized to enforce it.

The Fire Department of New York City contemplates examining engineers as to their fitness to operate ammonia refrigerating systems, charge them five dollars each for it and two dollars a year for renewal, notwithstanding that the Police Department now determines their competency to handle such machinery. Duplication of examinations before different departments is senseless. We have enough confidence in Commissioner Adamson's common sense to believe that he will exercise it by accepting the Police Department certificate.

Correspondence

Gas Temperature in Boiler Pass

In connection with the sectional view of apparatus in a turbine plant, included as a supplement to the Mar. 21 issue and the article on this subject on page 395 of the same number, we would call to your attention the temperature of 1,500 deg. shown in front of the superheater at the top of the first pass of the boiler, with a furnace temperature of 2,500 deg.

In connection with soot cleaners, designed for the type of boiler shown, the elements are carried across the tube bank at the top of the pass, and we have never found any boiler where the temperature would run as high as 1,500 deg. except in one or two cases where the furnace conditions were such that volatile gases and carbon monoxide were delivered in the tube bank in such quantities as to cause secondary combustion at the top of the first pass. This condition of secondary combustion at the top of the first pass is not good engineering practice, and we hardly believe that you intended to indicate any temperature conditions of these boiler gases that are not in accordance with good engineering.

A large number of soot-cleaner elements have been installed at the top of the first pass of boilers of the type hown in the diagram, the majority of these elements being of extra-heavy wrought-steel pipe. If this pipe were continuously exposed to a temperature as high as 1,500 deg., it would rapidly deteriorate and compel excessive repairs to the cleaner system. The fact that such elements have been installed for years in a large number of boilers would indicate that the temperature shown is not actually found in practice.

As further evidence that the temperature at the location shown is too high, we would refer to charts on pages 53 and 163 of Bulletin 18 of the Department of the Interior, entitled "The Transmission of Heat into Steam Boilers," by Henry Kreisinger and Walter T. Ray. The curves of Fig. 16, page 53, are taken from small experimental fire-tube boilers, and the curves of Fig. 75, page 163, are from a Heine boiler. The drop in temperature from the furnace follows the same law in both types and shows a much more rapid decrease in temperature during the passage of the gases over the first part of the heat-absorbing surface than has been shown in the temperature chart issued with the Mar. 21 issue. We have checked up temperatures in a large number of boilers of the Babcock & Wilcox type and have found the drop in temperature over the heating surface tallies closely with the curves shown in Bulletin 18.

Some three years ago we read a report made by the engineers of the Commonwealth Edison Co., of Chicago, on a 12-tube high Babcock & Wilcox boiler. Investigation covered by this report had been conducted to determine the efficiency with various degrees of superheat. The degree of superheat was controlled by the temperature of the gases delivered at the top of the first pass of the boiler, and this was varied by maintaining the boiler tubes with varying soot accumulations. The engineers conducting the test found that the maximum temperature obtainable when the tubes in the first pass were maintained free from soot was a little over 900 deg. F. at something over 200 per cent. rating. By maintaining a very heavy soot accumulation on the tubes of the first pass, a temperature of about 1,250 deg. was obtained at the top of the first pass. We unfortunately do not possess a copy of this report, but if one is available we should be pleased to have these figures checked, as they have been given from memory.

CHARLES DE VED,
De Ved-Kissick Co.

Philadelphia, Penn.

Casings for Anchor-Bolts of Machinery Foundations

The Jan. 4 issue contains a very interesting article by Bruce Page, on "Casings for Machinery-Foundation Anchor Bolts," which describes the different types of casings and their functions. "The second function of a casing," he says, "is to permit the removal of the anchor bolt." But some may ask, what is the use of removing

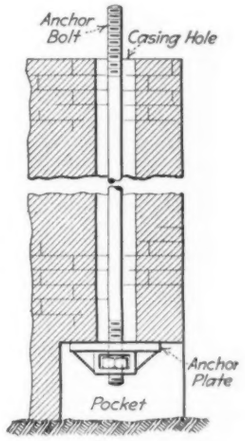


FIG. 1. SHOWING ANCHOR PLATE IN POSITION

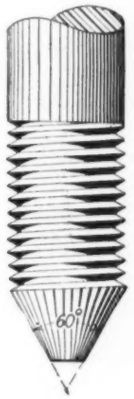


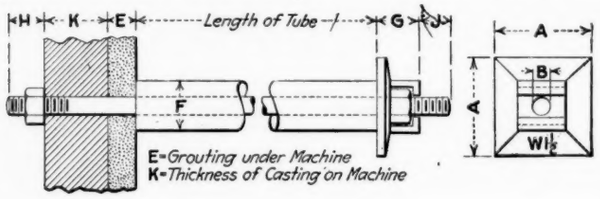
FIG. 2. TAPERED END OF ANCHOR BOLT

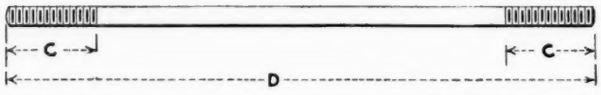
the anchor bolt? It frequently happens that the bolts project considerably above the top of the foundation; and if they can be removed, the machinery can be rolled in place without much trouble and the bolts may then be reinserted without having to raise the machine over the tops of the highest anchor bolts and then letting it down again when in place.

In replacing an anchor bolt after the foundation is set, it is necessary that it should screw into the bottom nut just as it was before taking out. This bottom nut can be held in place by an anchor plate, as shown in Fig. 1 of Mr. Page's article, herewith reproduced. The table, which gives the general dimensions of the different parts that make up anchor bolts, also shows a similar anchor plate or washer. The bottom nut should be square and the upper one hexagonal. The lower end of the anchor bolt should be tapered as shown by Fig. 2, the

end making an angle of 60 deg. and coming almost to a point, as shown. The taper on the end is to allow the bolt to find its nut readily, while the bottom nut is held rigidly in place by the anchor plate. This is the important point.

One case recently came up where the anchor bolts projected three feet above the top of the foundation and when





Size of Bolt	A	B	C	D	E	F	G	H	J	For Length of Tube Deduct for G+E+H+J & K	K	Weight of Washer in Pounds
	Letters Refer to Sketches Above; All Dimensions in Inches											
1	5	1¼	4	Length of bolts varies with each job	1	3	1¾	1¼	1¼	5⅝	Thickness of casting varies with different machines	6
1¼	6	1¼	5		1	3	2	1¼	2	6⅜		9
1½	7	1¼	5		1	4	2¼	2¼	2	7⅛		11
1¾	8	2¼	6		1	4	2¼	2¼	2	8⅛		16
2	8	2¼	6		1	4	3	3	2	9		16
2¼	9	2¼	7		1	5	3¼	3¼	2	9¼		56
2½	9	2¼	7		1	5	3¼	3¼	2	10¼		56

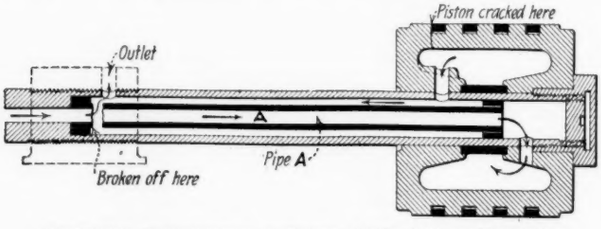
STANDARD DIMENSIONS FOR FOUNDATION BOLTS, WASHERS AND TUBES

it came to putting the heavy machinery in place, the superintendent on the job had the whole machine raised over the tops of the bolts and then let it come down again when in place. As this particular machine weighed several tons, it took considerable time and labor to do this work. He did not know that special care had been taken to permit the removal and replacing of the anchor bolts for this very purpose. He thought of removing the anchor plates, but he did not want to take any chances of not being able to find the bottom nut. J. E. Poche.

New Orleans, La.

Cracked Gas-Engine Piston

The article "Cracked and Seized Pistons" in the Jan. 4 issue brings to mind an experience I had with a 500-hp. horizontal double-acting gas engine. For some time the operators had been complaining that the engine worked badly. The speed fell off and became irregular, and



SECTION THROUGH PISTON AND ROD SHOWING FRACTURES

advancing the ignition to 25 or 28 deg. to get the desired speed caused unsatisfactory operation. The governor, regulators, mixing valves and air-starting valves were inspected and overhauled where needed, but the engine kept getting worse. It then became difficult to start, taking from two to six trials to get the engine going. With 225 lb. air pressure it would make two or three revolutions, then stop, and the air pressure would be gone. The timer was overhauled and some worn parts replaced, but without results, and the trouble seemed a mystery. Finally the engine developed a heavy thumping, and it was shut down.

The inlet and exhaust valves were inspected and ground in to make sure they were all right, and after about 18 hr. work the air check valves attached to the starting cylinder were removed for inspection, and here we noticed a slight trace of water in the cylinder. We then removed the cylinder head and turned on the cooling water, and a good-sized stream of water came from under the piston, indicating a bad leak. On taking out the piston, each ring was removed as it left the cylinder until the last one was removed; here the trouble was found, in the form of a crack in the ring channel about 15 in. long. The piston and rings gave indications that they had been overheated, the rings being stuck and charred in the channels, allowing the air to pass the piston and making it difficult to start.

The cause of the overheating and cracking of the piston is shown in the sketch. The pipe *A* inside the piston rod, which conveys the water to the piston, was broken off and parted about 2 in., letting the water pass to the outlet without going through the piston. The consequent overheating of the piston caused the crack.

Another bad feature of this engine was the loud report of the exhaust. This was overcome by tapping the exhaust pipe near the engine for a ½-in. water line at about 50 lb. pressure, and the sound was so deadened that it is not objectionable. Charles E. Nigh.

Morgantown, W. Va.

Oiling Valve Dashpots

I consider the points raised by Warren D. Lewis on page 263 of the Feb. 22 issue with reference to nonreturn valves well taken. Corrosion or any other cause that conflicts with their freedom of action may render them a source of danger rather than an element of safety.

I have seen both external- and internal-dashpot types of valve fail to open when the steam pressure in the boiler reached a pressure equal to or a little greater than the pressure in the header. I have also noticed times when neither type would close and cut the boiler out after they had been given ample time to do so, to the extent of leaving the header valves on the boiler open for periods of five or six hours after the fire had died in the furnace.

This statement of the occasional performance of certain types of valves does not voice a prejudicial opinion regarding the use of these most necessary articles of power-plant equipment or imply that the returns on the investment are not adequate, but rather, emphasizes the fact that nonreturn valves are not to be considered as carefree as the ordinary header valve, where an infrequent packing of the stem and an occasional renewal of seat or disk is all the attention required. As for the investment, any piece of apparatus intended to safeguard human life cannot be measured in the scale of dollars and cents.

I venture the remark that there are numerous plants where these valves were installed for the protection they offer to those within reasonable proximity and where, after the first or second failure to cut a boiler in or out, the main header valve was resorted to and this practice

continued, with the result of an inoperative property and life saver.

It is needless to say that this practice is not countenanced in properly managed plants, as it is only when a boiler is being cut in or out that the engineer has the opportunity of testing the reliability and proper functioning of the valve.

Time has educated the engineer to believe that there is nothing on top of his boilers that he cannot see or feel that can get out of order, and he retains this frame of mind after the installation of nonreturn valves. He knows there are invisible parts in his pumps and engines requiring his attention to keep them working properly; time and experience will also have to teach him that there are moving parts entering into the construction of this comparatively new device that need his care, even though necessity requires that they be located in such uncongenial places.

For these valves to gain the full confidence of the engineer, they should be as sensitive to variations of steam pressure as a windmill is to variations of wind velocity, as positive in their action as an ordinary check valve and reasonably accessible for inspection and care.

Chicago, Ill. J. W. Beatty.

"Safety First" for Power Plants

In regard to the article on page 373 of the March 14 issue, entitled "Safety First for Power Plants," I will have to be shown that the "Safety First" movement has been overworked. Perhaps some safety devices have not been made properly, but it is possible to place appliances that will protect thoughtless persons. If guards make operations on or around a machine dangerous, they are not properly designed.

It is sometimes necessary to instruct and train the careless ones to observe safety first. Even the most careful and thoughtful person may meet with an accident at one time or another about an unguarded machine, whereas if the machine is properly guarded, the probability of accidents is greatly reduced.

As it is possible to properly design mechanical guards for safety operation, it seems to me that such trouble as exists is in the design of the guards. Safety is a physical, moral and financial benefit to employee and employer. W. F. Johnson.

Howes Cave, N. Y.

Lubricants and Lubrication

In the article in the issue of Mar. 7, page 317, under the heading, "Lubricants and Lubrication," by John D. Morgan, various tests are given whereby most adulterations of lubricants "can readily be detected by any engineer by simple tests."

I do not understand how the percentage of free acid in an oil is to be determined by the method given in the article, as the weight of the 15.4 c.c. of sample taken would necessarily vary with the gravity of the oil. Then, too, there is not sufficient detail in the directions given for conducting the test.

The test for the detection of soap is considered wholly lacking in detail and is not to be carried out by means of the very brief method given. Also, the "saturated solution of metaphosphoric acid" mentioned should have read "saturated solution of metaphosphoric acid in *alcohol*."

In describing the test for rosin, it might have been advisable to have given the color produced, upon the addition of one drop of sulphuric acid, as violet instead of "red," also that the presence of cholesterol in animal fats would produce the same color as does rosin oil.

Oil Analysis, by Augustus H. Gill, will, I think, make the foregoing clear. William Blaisted.

Miami, Ariz.

Flickering Lights Cause Trouble

We have three Belliss-Crompton direct-current generating sets—one rated at 50 and two at 100 kw. at 450-550 volts—operating a three-wire overhead network with Crompton balancers. Only one machine is at present necessary to carry the load, which consists of metallized-filament lamps and fans.

We are experiencing trouble with flickering of the lights, which seems to synchronize with the engine beat, and are unable to find any cause for it. It does not always occur, being sometimes scarcely noticeable and at other times becoming objectionable. All the machines seem to be affected, but not to the same extent, the small set being the worst and one of the 100-kw. sets nearly as bad. The third set only occasionally gives trouble, and then it is slight. We have found that changing over to this set will practically stop the annoyance. The flicker seems to start at half-load on the first two machines when the busbar voltage is about 485 to 490. The machines have been in use only two years, but this flickering was noticed from the beginning.

I should greatly appreciate any information or advice that *Power* readers can offer as to the probable cause and remedy of this trouble. F. C. Bulsara.

Nagpur, India.

Sudden Cooling of Hot Boiler Plates

In support of the stand taken by R. N. Blackburn in the Nov. 16, 1915, issue (which has only recently reached me), relative to the sudden cooling of hot boiler plates in case of low water, I would state that I have practiced this when forced to it and have experienced no trouble, nor have I damaged a boiler, except once. It was an internally fired marine boiler with a crown-sheet at the back end; there was no fusible plug.

It was my "trick" in the fire hole when we left port, one man doing duty as fireman and engineer. When my relief came on, he was slightly under the influence of liquor. With a word of caution I left him and went to my bunk. It was about two hours later when I was brought back from dreamland, excessive heat making sleep impossible. It soon dawned upon me that everything was not well in the fireroom. Steam was escaping somewhere. The fireman was talking to himself and trying to get the injector to start. I found that there was no water in the boiler. The captain informed me that we could not stop, as we were in a narrows off a very bad shore. It was a case of keep going or pile up on the rocks. After cooling the injector, I took what I thought was the chance of my life and turned on steam. I was prepared for anything then—straight up or down, I did not know which—and I

confess I had a notion of going overboard, but nothing happened, so we took heart, built a small fire and waited half an hour for the water to show up. Steam was leaking out of the main lead at the union. Examination showed that the lead gasket had melted, no doubt because of the high temperature the steam had attained. As soon as possible an examination was made of the boiler, and the only damage found was a half-dozen leaky stay-bolts.

There is a possibility that, had this been in a stationary boiler, a different story might have to be told, as the rocking and pitching of the boat dashed water on the crown-sheet and kept it from getting red-hot.

J. A. DESPARDINS.

Rocky Mountain House, Alta., Canada.

What Caused the Pressure Fluctuation?

Charles Haeusser's letter in the Feb. 22 issue is interesting. The experience that he relates I also had recently. A 60-in. by 16-ft. boiler was cut out of service for a week, but the pressure never went below 40 lb. I lifted the safety valve to be sure the pressure was not due to air. Also the boiler kept filling with water; I had to blow it down several times. I noticed the water was getting colder each time and the last time was quite cold. Search for leaks from the other boilers revealed none.

I then fired the boiler slowly, when the pressure just as slowly went down. If I fired a little briskly, the pressure went down faster. When it had reached 15 lb., it stood stationary for a few minutes, after which it rose until the normal working pressure was reached.

When I cut the boiler out of service again, I found out what was the matter. The water column of each boiler is connected by a ½-in. valve to a ½-in. steam pipe that carries the pressure to the engine-room steam gages. The valve seat on this boiler had become cracked and leaked enough steam to keep the pressure at 40 lb., some of this steam condensing and filling the boiler.

Mr. Haeusser is right when he says that the circulation of cold water from below brought the pressure down.

Lake Preston, S. D. GARDY E FORGARD.

Chalk on Greasy Belts

For several years I was foreman of the power and testing department of a large gasoline-tractor factory. The tractors are belted to dynamos which absorb the power and at the same time generate the power used in manufacturing. Sometimes ten of these units were in service, operating in parallel, and most of the tractors developed 60-hp. or more. At first 10-in. two-ply leather belts were used. It became evident that wider belts were needed, but the design of the tractors limited the width to 12 in. Even then belt troubles were frequent. Inexperienced men did not know how to line up a tractor or back it into the belt, so that many belts were torn or stretched unevenly. Oil also caused serious trouble, and because some of the dynamo pulleys were too small, it was no unusual thing to have a greasy belt slide off the pulley and be badly torn, if not ruined. Before long the policy was changed and slow-speed dynamos with 20- to 24-in. pulleys were used.

We learned to treat all new belts before putting them in service. Each one was thoroughly coated with some good belt dressing and laid away in a warm place so that the dressing might be absorbed, and all had riveted joints and rivets spaced at 12 in. intervals on each edge. This added to the life of belts, but the grease soon made them very slippery.

Quite by accident we found that powdered chalk was good. A pail of it was kept in the power house, and whenever a belt seemed to be slippery the chalk was dusted on so that it was carried against the pulley. Most of it combined with the grease and was thrown from the belt, but some of this black gummy mixture would stick to the pulleys and had to be scraped off by holding a sharp pine stick against the pulley while the machine was running—dangerous perhaps, but it saved stopping an engine. When the belt surface became too dry from the chalk, dressing was applied sparingly.

Extra belts were always sprinkled liberally with chalk before they were rolled up. Because of the hard service the belts were so short-lived that we never determined whether there was any bad effects from using chalk, but with larger pulleys and riveted belts on which we used good dressing and plenty of chalk, our troubles were greatly lessened. CLARENCE V. HULL.

Charles City, Iowa.

Making Potassium Pyrogallate

It is best that potassium-pyrogallate solutions for use in gas analysis be made fresh at intervals of not more than three days apart. For legal analysis the solution must have been made just previous to the determination. This is necessary on account of the unstable nature of the solution. It is better to keep the solution in the following manner: Make a solution of potassium hydrate, KOH, by dissolving sticks purified by alcohol in distilled water to saturation. Keep the pyrogallic acid, $C_6H_3(OH)_3$, in powder form in a cool dry place.

If it is desired to make the solution of potassium hydrate for use in determining CO_2 as well, it can be made by dissolving 150 grams of the chemical in 500 c.c. of water. The potassium hydrate can be added to the pyrogallol as it is used, in the proportion 20 grams pyrogallol to 200 c.c. of the potassium-hydrate solution just mentioned. For everyday work a method that is easy and accurate enough is to place 4 c.c. (one teaspoonful) of pyrogallol in a beaker and add potassium hydrate until a deep wine color appears. As the solution is an alkaline pyrogallol, an excess of potassium hydrate does not harm the determination. However, where hydrocarbons are to be determined after this operation, an excess of it should be avoided, as it tends to absorb the hydrocarbons. H. E. WEIGHTMAN.

Chicago, Ill.

Power from Pumping Plant

I have read with interest the article, "Power from Pumping Plant," by H. A. Megraw, page 295 of the Feb. 29 issue, in which he describes how a part of the power expended in operating a pumping plant was recovered and applied to further use.

A similar thing has been done by the Philadelphia Rapid Transit Co. at its power plant, 33rd and Market St. Here the condenser circulating water is pumped to a large cooling tower on the roof of the power house,

and the return is passed through a turbine and a large percentage of power is saved. It is necessary to use a turbine in this instance instead of a Pelton wheel, on account of the great variation in the quantity of water for the different load conditions. This plant was put in service in 1910, and I understand that it has been in operation ever since. E. P. HAINES.

Philadelphia, Penn.

Boilers in Good Condition After Ten Years

The photographs shown were taken inside one of our return-tubular boilers, which have been in service for nearly ten years and are practically as free from scale

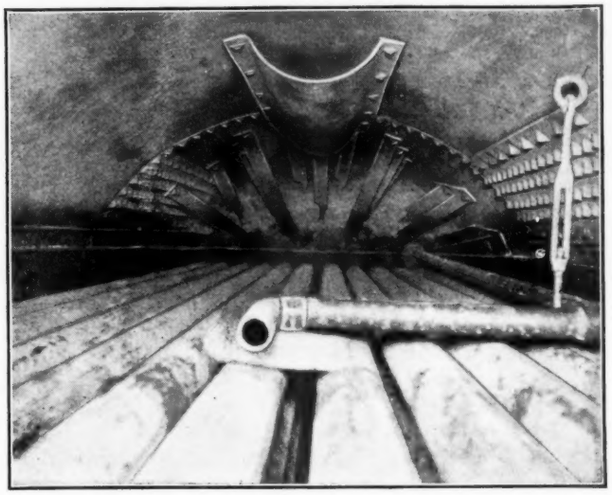


FIG. 1. VIEW OF BOILER ABOVE THE TUBES

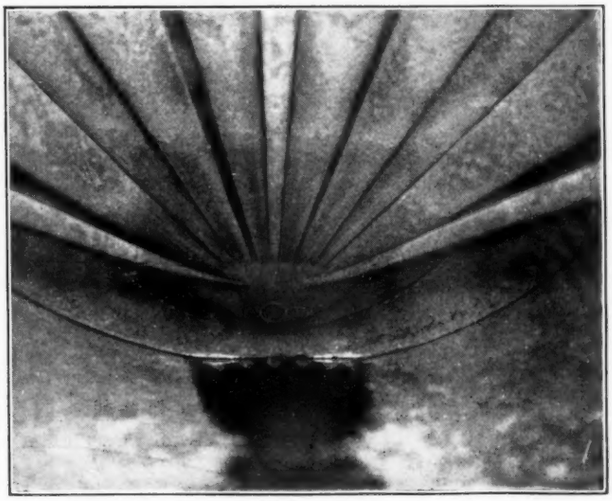


FIG. 2. INTERIOR OF BOILER BELOW THE TUBES

and corrosion as when installed. It appears that there is scale on the tubes and sheet, but there is none. The dark "patch" in Fig. 2 is water.

These boilers are 6 ft. 6 in. diameter by 20 ft. long, have eighty-four 4-in. tubes, grates 7 ft. by 7 ft. 6 in. We treat the water daily with a marketed compound and add a small quantity of graphite. ASA P. HYDE.

Binghamton, N. Y.

Hand Pump or Squirt Gun

A handy squirt gun for use in caring for hydraulic elevators was made of old material lying about the shop. A brass tube 2¼x13 in., two old grease-cup pistons ½ in. long, with their spring guides ⅝x4 in., two pieces of leather from shoe uppers, a ¼-in. brass rod and a piece of corrugated rubber put on the outside of the tube to keep the hand from slipping constituted the bill of material.

The grease-cup pistons, one to stop up each end of the tube, were almost the right size to begin with. By taking a thin skim off one piston and drilling a ⅜-in. hole through it and the spring guide, a driving fit was made in the spout end. At the handle end the piston was made to fit easier and secured by three screws, for removal when necessary to clean or renew the cups. A ⅜-in. hole was drilled at this end for the rod to pass through. Three brass disks were used to separate and clamp the leather cups, the two outside ones being ⅛ in. smaller than the center one and the cups were put on facing in opposite directions (back to back). A nut on the rod at each side holds the disks and cups in place. A small piece of wood attached to the outer end of the rod forms a handle and completes the gun, or pump.

The spout is ⅛ in., and the contents (more than a pint) will not drip out. This is a great convenience for removing the water that collects in high-pressure elevator plunger-pans. It is quicker and cleaner than baling out with a tin cup, and no water drips down the shaft.

Newark, N. J. W. T. OSBORN.

Commutator Bar Missing

A short-circuited coil in the armature of a dynamo or motor is likely to burn out quickly. Although it may carry none of the line current, the affected coil is essentially a short-circuited loop which turns in a strong magnetic field when the armature is in motion; the e.m.f. of the loop is appreciable and the resistance small, therefore the local short-circuit current is abnormal and quickly heats the coil to a temperature that can destroy its insulation. The short-circuit may be due to a cross in the coil itself or in its leads or to a bridge between the two commutator bars to which the coil connects. In the following case the cause was unusual, but its effect was the same as that due to any of the causes just named.

An armature was sent to a repair shop for a new commutator or for the old one to be refilled, because the bars had worn so thin that they were buckling. Upon replacing the armature and starting up after making the repairs, it immediately began to smoke. As no other part of the machine had been touched, the trouble evidently was in the repaired armature. Careful inspection and test failed to reveal any mechanical abuse incident to carelessness in handling or any bridged bars due to the turning tool dragging burrs or to the grooving tool jamming copper slivers down into the side micas. The armature was rejected and was returned to the repair shop to be corrected; in a few days it was again received and installed and its operation was perfect.

As satisfactory operation was all that interested the operator, he did not try to find out what was the matter with the armature. It was learned later, however, that in refilling the commutator, it had been assembled with

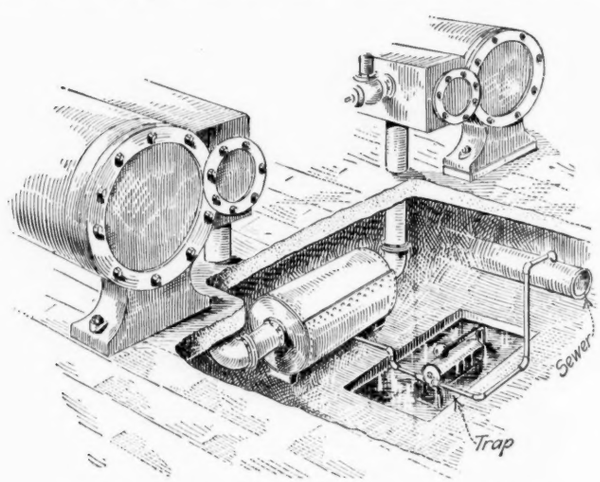
one of the bars missing. An experienced winder should have detected this in laying down the bottom leads, because there would have been no vacant bar into which to place the last lead. Either the winder was not experienced or he did not care, for he went ahead and connected the armature, leaving one coil out of the connection. Instead of cutting the leads of the idle coil off and insulating them, he very carefully connected them together. The result was a short-circuit, which had to be eliminated before the armature could be made operative.

Schenectady, N. Y. E. C. PARHAM.

Pit Water Caused Trap Trouble

Several years ago, while I was employed as a power-plant efficiency engineer, a 500-hp. cross-compound, direct-connected Corliss engine at one of the plants of a large corporation continually gave trouble by breaking valve-gear parts. The engineer in charge attributed it to high speed—125 r.p.m., which I did not consider excessive. The engine finally broke a low-pressure exhaust-valve eccentric rod. It was welded and the engine started up and ran for about five hours, when the low-pressure exhaust rocker-arm broke. I was sent to investigate and report, if possible, the cause.

Upon arriving at the plant, I found the cylinder head had been removed, and an examination of the interior of the cylinder showed it to be in fairly good condition. The exhaust valves were removed and examined for any marks that might indicate that some obstruction had gotten between the valve and the valve seat, but nothing was found. The valve gearing was also examined for marks that might indicate that a wrench or other obstruction had been caught in the valve gear, causing the rocker arm to be broken, but no marks were found.



TRAP AND PIT THAT FILLED WITH WATER

The shift engineers all claimed that the engine would run smoothly for weeks at a time without any bad breakage, and then disaster would befall it and many valve parts would be broken. The storekeeper at the plant stated upon inquiry that about $2,000 worth of low-pressure parts had been broken on that particular engine in the past three years.

When the new rocker-arm arrived, it was put in place, the engine started up and put to work on the power generation. This engine had a vertical receiver, in a pit between the high- and low-pressure cylinders. The pit was covered with a trap door, making it rather inconvenient and inaccessible.

I had arrived at the conclusion that this receiver periodically filled with condensation and allowed the water to carry over into the low-pressure side. I went into the pit and remained there all of one forenoon, during the first day's run after repairing the engine. The receiver was drained by a tilting trap in a small pit, and I noticed that this pit gradually filled with water. It was drained by an ejector periodically, operated from the engine-room floor. When the pit filled with water, it would buoy up the tilting bucket of the trap, allowing the latter to fill with water from the receiver, but would not allow it to discharge until the water was siphoned out of the trap pit with the ejector.

A telltale was installed on the trap pit, and forcible instructions were given to the operators that the trap pit must be kept drained at all times so that the trap could operate properly, thereby eliminating the breakage.

Inquiry regarding this particular engine about a year afterward brought out the information that it had not broken a part since keeping the trap pit drained.

San Francisco, Calif. V. R. HUGHES.

Needless Wastes in Power Plant

Upon taking charge of a new plant I found that, although the load carried was much lighter, the water bills were considerably higher than in my previous plant.

Investigation disclosed that the returns from a large exhaust-steam heating system were being discharged to the sewer because of oil and that the water trapped from the live-steam drying coils, from steam separators and from the high-pressure process heaters was being returned to a tank that was too small, and as a result about one-half of the returns was wasted through the overflow. Furthermore, no attempt was being made to reclaim the drips from a number of exhaust heads and drains in several parts of the heating system.

The boiler feed-water heater was found to be overflowing constantly because of a defective water-admission valve, and several blowoff valves were leaking and wasting considerable water. A number of washing faucets throughout the plant were also running a full stream continuously because of leaky valves.

The defective valves were at once replaced or repaired, all the clean returns were collected and brought to a large return tank, and the oily returns were first passed through a skimming tank. The first month's operation showed a saving in water sufficient to pay for the sundry and supplies account for the plant. M. SALLER.

Philadelphia, Penn.

Wisdom in Plant Operation

It is easy in power-plant operation to lean too much toward the refinements and higher technique of the work to the neglect of the more humble and commonplace problems and conditions requiring only good common sense and judgment. By becoming so involved in these ultra refinements, ordinary wasteful conditions are apt to get by unnoticed.

I once took charge of a plant that seemed to be in first-class condition. The engines were shining and running

splendidly, and not a steam leak could be seen or heard. The engineer had spent hours indicating the engines and could figure the steam consumption to a nicety, and he kept the most elaborate plant records I ever saw. But there were numerous steam traps with large quantities of steam blowing through each one, and several were discharging good clean condensate and steam into the sewer. While all the steam piping inside of the plant was faultlessly covered, there were several bare pipes exposed to rain and snow, carrying live steam to outside buildings. The boiler blowoff valves were leaking badly into the sewer, where the discharge could not be seen. Water, an expensive item in this plant, was going to waste in a lot of places.

Without making a single calculation I was able to cut down the fuel consumption 40 per cent. and the water consumption 55 per cent. and was able to prove by the past and present records a saving in the total monthly operating cost several times the amount of my salary, which was up to the average. This is not a knock against scientific plant operation. It is a suggestion to take into consideration the whole plant and not to go to extremes in any one direction, but to keeping a level head and remember that about 95 per cent. of the improvements can be made without elaborate mathematical calculation or tests. To effect the other 5 per cent. the case is different, and I sincerely believe every engineer should go after that too and at all times do the best he is capable of, not only for his own good and satisfaction, but for the dignity of the profession. W. G. Camp.

Ash Fork, Ariz.

Over-Travel of Accumulator

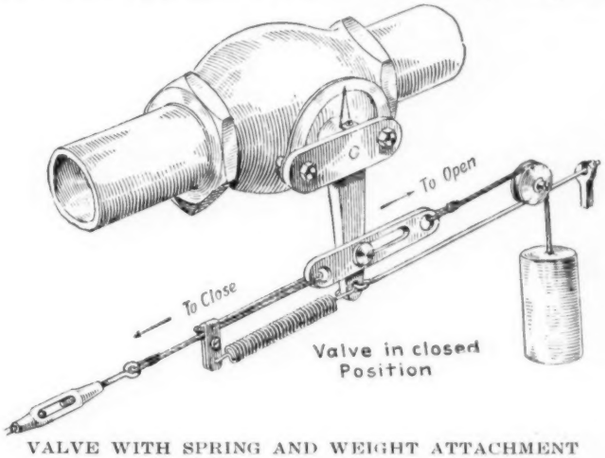
Considerable trouble has been caused by over-travel of the accumulators on our hydraulic system. The steam to the pumping engine is cut off by a chronometer valve, which is closed by the accumulator when at a given point. As the valve has but little lap, a slight over-travel would cause the steam to be admitted again to the engine, and after this occurred the greater the amount of over-travel the more steam was admitted, and the accumulator would be pumped up to the blow-holes in the rod, with steam wide open on the engine.

The lever on the chronometer valve was clamped to the valve stem so as to slip when the valve was at the point of over-travel. The valve had been held by being in contact with a lug on the inside, but this had been broken at some previous time and was useless. Anyhow it would not be satisfactory, as it was possible for the valve to move off its seat a little on account of the adjusting screw being set in too far. This would cause the engine to creep so that every time the accumulator went up it would displace the lever or break the rope, making it necessary to set the lever again. In fact, the valve would be unseated by the expansion of the stem if set when cool, and if set when hot, the contraction would allow it to seat so firmly that the weight would not open it, as it was unbalanced when closed, and the accumulator would come down. A man was kept at the engine all the time.

The trouble was aggravated by the fact that the engine was a three-cylinder compound with cranks set at 120 deg. and had an automatic bypass to the receiver controlled by the discharge pressure in the pump, a check valve being placed in the line beyond the connection to the bypass.

When coming to the point where steam was to be cut off by the chronometer valve, the engine, being under pretty good headway and having two heavy flywheels, would complete over two revolutions after being cut off, being kept going by the receiver steam and the flywheels. Those two revolutions would displace the accumulators enough to pull the chronometer valve across its seat and admit fresh steam into the engine. After this nothing would prevent overpumping except shutting down by hand.

This was a dangerous condition. The simplest cure was to let the flywheel spend its energy without pulling the steam valve open, and this was accomplished by using the



VALVE WITH SPRING AND WEIGHT ATTACHMENT

slotted lost-motion link shown in the illustration. In place of a spring I first used a pulley and backweight, but found that it was harder to adjust the length of the valve stem, as the weight would pull the valve closed, and if the engine stood idle for a few minutes, it took a great pull to open the valve. This would often result in the engine remaining closed off while the accumulator crept down—another dangerous condition. By using the spring as shown, when the valve is line and line with its seat the unbalanced pressure will overcome the spring and very little pull will be required to open it.

This arrangement has been giving entire satisfaction for over a year, and as I was able to dispense with an extra man, the saving has been worth while.

Recently I put an indicator on the valve stem, so that I can tell at a glance whether the lever has moved on the stem. I use a turnbuckle to compensate for stretch of the rope or any other slight derangement.

Trenton, N. S., Canada. J. A. McGilliway.

Black Spots on Commutator

I noticed a letter in the Mar. 14 issue on "Unusual Commutator Trouble." I had a similar occurrence on a 75-hp. 6-pole 500-volt direct-current motor driving a pump. Several years after installation the motor began to show groups of four black bars, spaced equidistantly at six places around the commutator. We at once changed to softer brushes, and after pumice-stoning the commutator, started the motor again, the brush rigging having been taken off and thoroughly cleaned meanwhile. After several days the same trouble developed again. This time we decided that it was in the winding, so new coils were put in, and the motor gave no further trouble.

This same trouble developed on a 300-kw. 750-r.p.m. 500-volt three-bearing motor-generator set, showing up

at eight equidistant points on the commutator. We reset the brushes, cleaned the rigging and pumice-stoned the commutator, but after the machine had been running again for several days the same trouble developed. There was no flashing, and the machine easily carried full load. After the trouble showed up the second time, softer brushes were substituted and set at a greater angle than those we had been using. This appeared to rectify the trouble.

We had a 250-kw. 250-volt generator that developed a ground under several of the commutator bars, between them and the ring. We cut the cord off the mica ring and thoroughly dug out all the burnt mica, being careful of the bars. This done, we filled a cup with ground mica and thoroughly mixed it with liquid shellac, making a pasty compound. We then packed this mixture in the crevice where the burnt mica had been cut out, covered it with a piece of ribbon mica and finally rewrapped it with the cord. This trouble did not develop again.

On another 250-kw. machine we tried every possible brush-setting method known, to prevent flashing. While operating, this machine appeared as if it were running with an open circuit. We tried new brushes, different setting, thoroughly cleaned and oiled the commutator, rang through the machine for grounds and apparently found everything all right. Eventually we found a grounded shunt field and had to strip the machine to remedy this trouble. H. J. NELMS.

Ellwood City, Penn.

Motive Power for Auxiliaries

To give the highest efficiency in power-plant operation, the proper balance between feed-water temperature required and auxiliary exhaust available is essential at all times. Some of our leading makers are sending out auxiliaries with both motor and turbine drive, so as to obtain the best results at different loads. A big Detroit station has a separate turbo-generator with a variable vacuum jet condenser using feed water for injection and most of the auxiliaries electrically driven. The electric drive is ideal, but should not be used to feed a boiler with cold water when good heat units are wasted in the circulating water.

Why not have all auxiliaries electric driven, employing alternating-current motors where convenient and direct-current where speed changes are required, using a simple noncondensing turbo-alternator of ample capacity to generate current for this purpose with a motor-generator set for the direct current, the auxiliary busbars to be tied in with the main bus and the auxiliary alternator floating on the main line? The steam supply to this turbine could be automatically controlled by the back pressure in the feed-water heater. During periods of light load the main units would supply most of the power required for auxiliary purposes, while at times of peak load, when there was a heavy demand for feed water, the auxiliary turbine could supply current to the main bus if necessary to get sufficient exhaust for heating the feed water.

The auxiliaries could be protected from shutdown, if the main units dropped their load, by a low-voltage release on the tie switch to the main bus. This could also be designed to throw off the automatic control on the auxiliary turbine and let it run with its own governor, which would be set a little high, so as not to interfere with the other control during normal operation.

It seems to me that this outfit would not be much more expensive to install than the usual collection of steam-driven auxiliaries with operating troubles and complicated pipe systems, would be much more simple than the Detroit design and would still have all of its advantages

Cohoes, N. Y. R. G. YAXLEY.

Increased Plant Efficiency

It is interesting to note the value of small increases of efficiency in several departments. Each increase in itself does not seem to amount to much, but when the over-all efficiency is computed the saving often becomes surprisingly large.

A large factory, spending $10,000 per year for coal, was desirous of increasing its capacity 50 per cent. It was at first believed that it would cost considerable in new boilers and engine, but an engineer was employed who studied the plant and concluded that an additional engine would not be necessary.

The efficiency of the boilers was increased from 70 to 75 per cent.; that of the steam engine from 8 to 10 per cent.; and the efficiency of the belt and pulley transmission from 70 to 80 per cent. On figuring the over-all efficiency, we get $70 \times 8 \times 70 = 3.92$ per cent., before the slight improvements were made. After increasing the efficiencies we get $75 \times 10 \times 80 = 6$ per cent., something worth while, as it is an over-all increase of 2.08 per cent., which is 53 per cent. greater than the original.

The engine had not been pulling its most economical load, and it was made to do more work by increasing the vacuum and the steam pressure a trifle.

The only purchases made were an additional boiler, more transmission equipment and more machines. The increase in capacity was made at a satisfactory figure.

New York City. S. F. WILSON.

Power-Plant Diary or Logbook

Experience has shown that it is extremely desirable to keep a diary or logbook of our power-plant work.

We have a 10x13-in. book in which is recorded the general doings in the plant, one page being reserved for each day of the year. For example, when we begin using a new grade of oil on any of our engines, when a new piece of equipment is received and when first put into actual service, a note is made in the book. The record also shows which men were at work and any visitors, such as inspectors, erecting men on equipment being installed, or salesmen. Any special happenings in the plant are also noted, as for instance, when any equipment breaks down or is forced out of service.

While these data may for the most part be only a matter of interest, we have found them to be of great value a number of times where it was necessary to refer back to establish starting dates of equipment, time spent on the adjustments, etc. In connection with running trial tests on oils or coal, the record is of great value.

Part of the routine of the day is to enter up, as early in the morning as possible, the items of the previous day so that all the details will be available for future reference. Little time is required to keep the record—the hardest part is to get started and keep it going for a time, after which it becomes part of the day's work.

Philadelphia, Penn. M. SALLER.

Meeting of the New Haven Section, A. S. M. E.

The spring meeting of the New Haven section of the American Society of Mechanical Engineers was held on Apr. 5, this being a joint meeting with the civil, electrical and mining engineers. There were two sessions, that in the afternoon being held in the Mason laboratory of Yale University, at which was presented a paper on "The Water Powers of New England," by H. I. Harriman, of Boston. After giving a general outline of the possibilities of hydro-electric power development in the New England States, the speaker described the various developments of this character that have been placed in operation during the last few years by the New England Power Co. on the Deerfield and Connecticut Rivers. The descriptions were fully illustrated by lantern slides showing clearly how various obstacles had been overcome.

The discussion was opened by R. J. S. Pigott, power engineer of the Remington Arms Co., who combatted the idea that the central station of either the hydro-electric or steam-driven type could hope to replace the isolated plant except under conditions favorable to the central-station service. The experience of the new Remington Arms plant was cited as an example of how the central station could not hope to compete under conditions favorable to the isolated plant

It was pointed out by the speaker that this plant was exceptional in many respects to the average isolated installation, the size being much larger than usual—in fact, about 2,000 kw. larger than the central station furnishing light and power to Bridgeport. The Remington plant, which uses large quantities of steam for heating and manufacturing purposes, is provided with bleeder turbines, the cream for power purposes being removed from the steam by these machines, as Mr. Pigott expressed it, leaving a large heat content in the steam for the various manufacturing requirements. By apportioning the cost for power and manufacturing on a basis of the heat delivered and used for each kind of service, the power cost was shown to be so low that it would be impossible for a central station to compete even under the very best conditions for the manufacture of power. It was stated that in general the central station could not compete with the isolated plant where the capacity required was 1,000 kw. or over.

Mr. Pigott's discussion included some experiences with electric drives for machine tools, which had indicated that the power requirements of tools as recommended by the tool manufacturers were entirely unreliable. This was especially true of such tools as performed milling operations and work of a similar character, where it was found that the makers' recommendations always greatly exceeded actual requirements for real economical operation.

Following this discussion, Samuel Ferguson, of the Hartford Electric Light Co., spoke of the great advantages to be gained in combining the work of the hydro-electric and steam-driven central station on a basis which would permit the exchange of power between plants under separate ownership—that is, the hydro-electric plant to deliver power to the steam plant at the time of high water and the reverse exchange to occur when low-water conditions were experienced. It was pointed out that it is simpler and better to arrange an interchange of power under such conditions on an exchange basis rather than on a purchase basis and that the parties to the transaction would thereby be more likely to reach an agreement satisfactory to both.

John W. Lieb, of the New York Edison Co., was the next speaker and was followed by a number of others who discussed the various features involved in the generation and utilization of power. It was pointed out by Professor Breckenridge that the chief power requirement of Connecticut industries was cheap power.

Professor Scott, of Yale, referred to the relatively small cost of the energy required for light and power in the average manufacturing plant and spoke of the great economy that might be derived by supplying such energy in abundance in order to make a small saving in the labor cost by improvement in facilities for performing the work required.

One speaker pointed out the unfavorable condition now existing for water-power development in the valley of the Naugatuck River on account of the narrowness of the valley over a great part of its length and the fact that any attempt at securing adequate storage to make this stream fully effective would mean the abandonment of many small settlements and a large amount of railroad right of way at an expenditure out of all proportion to the returns to be expected.

At the evening session Samuel Insull, president of the Commonwealth Edison Co., Chicago, read a paper profusely illustrated with lantern slides describing the progress and development of the industry of making kilowatts from the time that he went to Menlo Park in 1881, as Mr. Edison's secretary, up to the present. Slides were shown of Menlo Park and some of the earliest electric stations and the struggles of the growing art described most interestingly by this man, who has had such an intimate and prominent part in that development. Later he dealt with the modern station, illustrating his remarks largely by slides from the Commonwealth stations. The paper finally discussed some commercial features of the electric business, in which the trend of development and relation of values, etc., were strikingly set forth in diagrams.

Meeting of A. S. M. E. and A. I. E. E. at Philadelphia

A joint meeting of the local sections of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers was held at the Engineers Club, Philadelphia, on Monday evening, Apr. 10, to discuss "The Possibilities of Some Prime Movers Now Under Development."

The opening talk was by A. D. Skinner, of Erie, who described and showed slides of the Skinner "univalve" unaflow engine, emphasizing the feature of this engine whereby the auxiliary exhaust valve comes into use when running noncondensing.

He was followed by W. C. L. Eglin, of the Philadelphia Electric Co., who took up some of the limiting features of large turbo-generators. Reverting to the days of the large reciprocating unit for central-station service, he said that the relatively low engine speeds with the consequent large diameter of generator had had more to do with limiting the capacities than the engine itself. The high speed of the turbine has removed this limitation, so that we now have designs for machines of 70,000 kw.

If much greater capacities are to be had, Mr. Eglin believed that the solution lay in greater rotative speeds, in which case it would be necessary to disregard the factors of safety now in use. He considered it expedient to resort to speeds that would stress the blades to within, say, 10 per cent. of their elastic limit and rely upon a casing ring for protection in case any blades should let go. The importance of blade failure has been over-estimated and the danger from the rotating element being unbalanced, either mechanically or electrically, is far greater. Concerning workmanship the speaker's experience had led to the conclusion that European turbo-generators are ahead of many of American make.

The last speaker of the evening was W. B. Pearsall, of the Southwark Foundry and Machine Co., who traced the development of the Diesel engine, with special reference to marine service, and then described in detail the Harris-Southwark Diesel engine.

Classification of Technical Literature

The Joint Committee on Classification of Technical Literature, composed of representatives of the leading technical, engineering and industrial organizations of the country, met on Saturday, Apr. 1, in the Board Room of the American Society of Mechanical Engineers. Henry W. Peck, of Schenectady, presented a progress report outlining the way in which the committee came into being and reviewing its work to date. W. P. Cutter, librarian of the Engineering Societies Library and secretary of the executive committee, presented a paper on "How to Make a Classification." After considerable discussion as to the relative merits of the plan recommended by the executive committee—that of assigning the classification of various divisons of the subject to the societies dealing with those specialties—and that of employing a professional to prepare a tentative classification for later discussion and revision by the respective societies, it was decided to adopt the recommendation of the executive committee as more in accord with the means at the disposal of the committee.

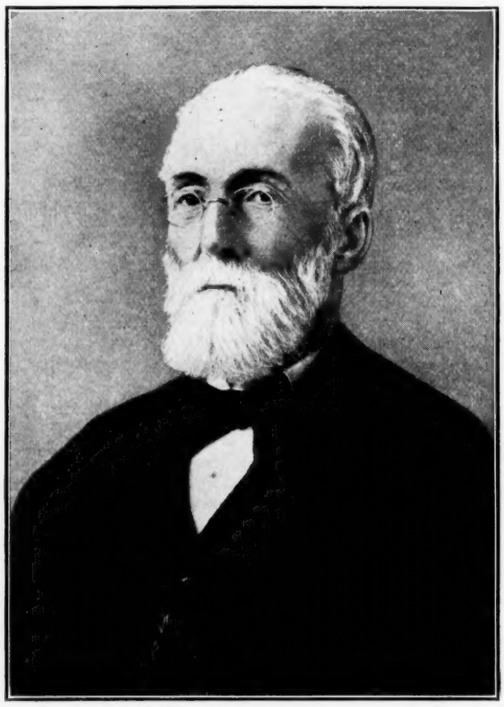
F. R. Low resigned the chairmanship of the executive committee in favor of Henry W. Peck, who has been actively identified with the movement from its inception.

Central Heating Plant for Providence Schools—A $60,000 central heating plant will soon be erected at Providence, R. I., in connection with the high-school group. Four buildings will be supplied from the plant, which will supersede several existing independent boiler installations. Plans and specifications are now being prepared, and it is intended to utilize the heating installation for purposes of instruction in the Technical High School.

Erasmus Darwin Leavitt

Erasmus Darwin Leavitt, honorary member and past-president of the American Society of Mechanical Engineers, died in Cambridge, Mass., Mar. 11. He was born in Lowell, Mass., Oct. 27, 1836.

After a public-school education he was an apprentice three years in the Lowell Machine Shop, following which he was employed one year by Corliss & Nightingale. In 1888, while assistant foreman for Harrison Loring at the City Point Works at South Boston, he directed the construction of the engine for the U. S. S. "Hartford." From 1859 to 1861 he was



ERASMUS DARWIN LEAVITT

chief draftsman for Thurston, Gardner & Co., Providence, R. I., then among the few builders of high-class steam engines. From there he entered the United States Navy in 1861, serving during the Civil War and until 1867, the last two years of which he was instructor in steam engineering at the Naval Academy at Annapolis. After that he engaged in the practice of consulting mechanical engineering.

In 1869 a simple condensing engine having a steamboat walking beam and cam valve gear was built from his design for the Plymouth Cordage Co. The engine is still in working order but has a Corliss cylinder and valve gear. Mr. Leavitt remained consulting engineer for the Plymouth Cordage Co. until two or three years ago.

Mr. Leavitt's real fame as an engineer began with the installation of the pumping engine at Lynn, Mass., which he designed with the assistance of George H. Norman. This engine was a beam compound, the cylinders being at the bottom and the beam overhead, and it marked an era in the economy of pumping engines, giving a duty under official test of 103,923,215 ft.-lb. per 100 lb. of picked Lackawanna anthracite. A pair of similar engines coupled together, but of somewhat larger size, were soon after built for the Lawrence, Mass., water-works.

Mr. Leavitt was appointed consulting engineer of the Calumet & Hecla Mining Co. in 1874, which position he retained until 1904. For this company he designed a great deal of heavy machinery for pumping, general power purposes, hoisting and stamping. The largest was the engine "Superior," with cylinders 40 and 70 in. diameter, stroke 6 ft. and speed 60 r.p.m. It was an inverted compound beam engine and drove hoisting drums and air compressors. The crankpin was 18x24 in., and the flywheel, 36 ft. diameter, was also a belt wheel.

Mr. Leavitt was a strong advocate of gridiron valves and all his designs employed them. He was equally strong in his advocacy of cams to operate them, but some of his later designs used other mechanism with dashpots.

Notable among Mr. Leavitt's other clients were Henry R. Worthington, the Dickson Manufacturing Co. and the Bethlehem Steel Co. He designed the first engine used for the cable railway of the Brooklyn Bridge; three immense sewage-pumping engines for Boston, one of 75,000,000 gal. capacity in 24 hr.; a pumping engine of 15,000,000 gal. capacity for the Louisville water-works, which in a 144-hr. continuous test surpassed all previous steam-consumption economies; a large engine for the Cambridge water-works; two for the New Bedford; a large one for the Boston water-works, etc. He was best known for his notable successes in the design of high-duty compound engines for city water-works service. He favored the locomotive-type boiler and used it almost exclusively.

Mr. Leavitt was one of the 30 mechanical engineers who organized the American Society of Mechanical Engineers in 1880. The degree of doctor of engineering was conferred upon him in 1884 by the Stevens Institute of Technology; this was the first time this institution conferred this degree. He was a member of the Institution of Mechanical Engineers of Great Britain for 33 years, and was made an honorary member last February. He also was a member of the Institution of Civil Engineers of Great Britain, the American Society of Civil Engineers, American Institute of Mining Engineers, Boston Society of Civil Engineers (honorary, 1908), American Society of Naval Engineers (honorary), British Association for the Advancement of Science (life member), the Franklin Institute and the New England Water-Works Association (honorary, 1906). He was a Fellow of the American Academy of Arts and Sciences.

Death of Eric Gerard, Belgian Scientist

Dr. Arthur E. Kennelly, professor of electrical engineering at the Massachusetts Institute of Technology and director of the electrical research laboratory, has received from Paris announcement of the death of Eric Gerard, of Liège, with the request to make the sad fact known to the many American friends of the Belgian scientist. Professor Gerard, who was remarkable in many ways, had the distinction of being the first person to teach electrical engineering as a separate subject.

Eric Gerard was born in Liège, Belgium, Sept. 22, 1856, and made that city his home till driven out by the German invasion. He was educated in the Belgian schools and received his degree of electrical engineer from the University of Liège. In 1879 he graduated and two years later joined the instructing staff of the university, where he remained professor till the beginning of the war. In 1883, when Senator Montefiore established the electrical institute that bears his name, a special school of the university, he became its director. The Montefiore Institute gives one- and two-year courses in electrical engineering. Gerard's later title on the faculty of the university was professor of electrical technique. With the habitude of Europeans in placing distinguished specialists at the head of public-service departments, he was inspector general of telegraphs for Belgium.

The Montefiore Institute was the first school to establish courses in electrical engineering.

As a writer Professor Gerard confined himself to technical subjects, which he handled with marked literary ability and especial skill and clearness. His more important volumes were the outgrowth of lectures to the students and include: "Lessons on Electricity and Magnetism," which has been translated into English, Russian and Serbian, the American edition bearing the date of 1897; "Electrical Measurements"; "Elements of Electrical Technique"; and "Electric Traction," the last a volume of 1900. Later he gave his attention in part to processes for plotting curves by photography. About a hundred pamphlets and brochures were written by Gerard. He was a visitor to this country as the Belgian representative to the electrical congress in Chicago in connection with the fair and made a tour of the country, winning many friends. He was also a delegate at Paris in 1900. He passed away on Monday, Mar. 27, at 8 Square Latour, Paris.

Locomotive-Type Boiler Falls—A 25-hp. locomotive type of boiler used for well-drilling purposes exploded near Ohio City, Ohio, Saturday, Mar. 11. It had not been in use for some time, and at the time of starting drilling it showed such defects as to require the services of a boilermaker. The explosion was caused by failure of the crown-sheet next to the tube sheet, tearing the crown-sheet toward the furnace door and pulling all the crown stay-bolts through the sheet. The boiler was blown 100 ft. from its original location. No one was killed or injured, although several persons were near-by. The state inspection law does not cover this size of boiler. The pop on this junk heap was set for 125 lb.

ENGINEERING AFFAIRS

The Electric Power Club, which is made up of manufacturers of electric motors, generators, transformers and controlling apparatus, will hold its annual convention at the Homestead Hotel, Hot Springs, Va., May 1-4.

The American Society of Safety Engineers will hold its next regular monthly meeting in the Engineering Societies Building, 25 West 39th St., New York City, on Wednesday, Apr. 26, at 8 p.m. The session will be devoted to a lecture on "Safety in Structural Steel Erection," by Owen Eachus, who has had charge of the erection of some of the largest buildings in this city.

Electrical Engineers to Discuss Water Power—On Apr. 26 the American Institute of Electrical Engineers will hold a meeting at Washington, D. C., under the auspices of the Washington section and the committee on development of water power. Several papers will be presented dealing with the relation of water power to the industries of the country, to transportation and to national defense. The primary object of the meeting will be to direct the attention of the public and of Congress to the fundamental engineering and economic principles that underly the water-power question.

Elmer Chambers Council, Universal Craftsmen Council of Engineers, held a country store and dance on Friday, Mar. 31, in the Assembly Rooms of the Lexington Opera House, New York City. The change from the usual entertainment brought out a big attendance, and a pleasant evening was spent. The committee introduced several unique novelties, which were greatly enjoyed. Songs were rendered at intervals by Miss Frances Maylander, Miss Mamie Syner, Miss Edith Northrup and Edward Murphy. The committee included Edward Northrup, chairman; Leo Kenney, Edward Tompkins and George Quilet.

The American Society of Naval Engineers held its annual banquet at the Army and Navy Club, Washington, D. C., Mar. 25. The large dining hall was filled to capacity, there being seated over two hundred members and guests. The toastmaster was Capt. J. S. McKean, U. S. N., and the principal speakers were: Hon Josephus Daniels, Secretary of the Navy, who spoke on "The Navy"; Senator James D. Phelan, "The Navy and Congress"; Hon. Ernest W. Roberts, "The Navy and the Country"; J. W. Powell, "The Navy and the Shipbuilder"; Rear Admiral W. S. Benson, U. S. N., "The Fleet"; William L. Saunders, "Industrial Preparedness"; Engineer-in-Chief R. S. Griffin, U. S. N., "The Naval Engineer"; Guy Mason, "The Navy and the Press." At intervals during the evening E. J. Dooner and Billy Murray sang songs and Jack Armour told stories. Capt. C. W. Dyson, U. S. N., is president, and Lieut. A. T. Church, U. S. N., is secretary-treasurer of the association. The banquet committee included Lieutenant-Commanders H. C. Dinger, J. H. Tomb, J. O. Richardson and Lieut. A. T. Church, all of the United States Navy.

MISCELLANEOUS NEWS

Another Electrical Week—In view of the excellent results attained through the "Electrical Prosperity Week" last December, the Society for Electrical Development is planning for another such campaign for 1916. This will be held Dec. 2-9 and will be officially designated as "America's Electrical Week."

Six Burned in Tube Explosion—The explosion of a boiler tube in the plant of the Polar Wave Ice and Fuel Co., Beaumont St. and Lawton Ave., St. Louis, Mar. 28, seriously burned six of the plant's crew. Edward Roberts, chief engineer of the plant, said the boiler had been inspected one week before the explosion.

Pittsburgh Steamship Co. Raises Engineers Wages—Harry Coulby, president of the Pittsburgh Steamship Co., announced a raise in wages of engineers. Chief engineers of first-class boats of the line will receive $2,160 for the year, assistant engineers $140 a month for ten months of the year and second assistant engineers $100 a month for ten months. Engineers of second-class boats will receive $1,900 a year and assistant engineers $115 a month. While no announcement has been made by the members of the Lake Carriers' association the wages paid by the Pittsburgh Steamship Co. the largest and most influential on fresh water, will probably govern all other lake wage scales.

PERSONALS

A. C. Harrington has resigned as general manager of the Marquette County Gas and Electric Co., Ishpeming, Mich.

William Tietze, formerly chief engineer of power plants for the Pierce Phosphate Co., Pierce, Fla., has become chief engineer for the Cudahy Brothers Co., Cudahy, Wis.

Charles W. Lotz has accepted the position of chief engineer of the Coxe Traveling Grate Co., Hazleton, Penn., with headquarters at the works in Port Carbon, Penn. He was formerly with the mechanical department of the Susquehanna Coal Co., Wilkes-Barre, Penn.

C. W. Obert, for the past three years associate editor of the publications of the American Society of Mechanical Engineers, has been appointed secretary of the American Society of Heating and Ventilating Engineers, with headquarters in the Engineering Societies Building, New York City. Mr. Obert will continue in the capacity of secretary of the Boiler Code Committee of the American Society of Mechanical Engineers.

TRADE CATALOGS

C. H. Wheeler Mfg. Co., Philadelphia, Penn. Catalog. Condensing equipment. Illustrated, 180 pp., 6x9 in.

Homestead Valve Mfg. Co., Homestead, Penn. Catalog. Homestead Quarter-Turn Valves. Illustrated, 44 pp., 6x9 in.

Joseph Dixon Crucible Co., Jersey City, N. J. Booklet. Dixon's waterproof graphite grease. Illustrated, 18 pp., 3½x6 in.

National Tube Co., Pittsburgh, Penn. Bulletin No. 26. Autogenous Welding of National Pipe. Illustrated, 52 pp., 8½x11 in.

Nordberg Mfg. Co., Milwaukee, Wis. Bulletin No. 27A. Nordberg high compression two-cycle oil engine. Illustrated, 16 pp., 8x10½ in.

Penberthy Injector Co., Detroit, Mich. Catalog No. 27. Injectors, valves, cellar drainers, oil and grease cups, etc. Illustrated, 80 pp., 6x9 in.

The Farnsworth Manufacturing Co. has recently been incorporated in Boston to manufacture and sell steam utilities under the patents of F. C. Farnsworth, consisting of tilting traps of every description. The new company succeeds the F. C. Farnsworth Co.

The J. W. Paxson Co., 1021 North Delaware Ave., Philadelphia, Penn., is now exploiting the "Farley" flue brush and "Fill-In" cement in the power-plant field. It has been making both articles for years but has devoted its sales efforts heretofore mainly to foundry equipment.

Classified Ads

POSITIONS OPEN

Canada

TWO MECHANICAL ENGINEERING DRAFTSMEN wanted; should have from six to eight years' experience designing. Apply by letter, stating qualifications and salary expected. The Canadian Copper Co., Copper Cliff, Ont.

New Jersey

AN ENGINEER wanted in the power plant of a large factory in New Jersey; must have experience in the operation of compound Corliss engines and be familiar with a.-c. and d.-c. current as well as the handling of switchboards, motors, etc.; he should also be thoroughly familiar with boiler-house practice and should have machine-shop experience; must be willing to work either on a day or a night shift; this position will be open around the first of June; a good opportunity at good pay for the right man. Address, stating age, married or single, experience, references, salary expected, and other particulars to P766—Power.

Pennsylvania

SEVERAL FIRST-CLASS DRAFTSMEN wanted at once, of general mill and blast furnace experience; state age, experience, present salary and salary wanted in first letter; also when available; central location, Pittsburgh. P687—Power.

SEVERAL DRAFTSMEN wanted at once, experienced in power plant and general piping work; state age, experience, present salary and salary wanted in first letter; also when available; central location, Pittsburgh. P688—Power.

Employment Agencies

CORRESPONDENT

THE UNDERSIGNED plans and conducts correspondence for positions in technical, manufacturing and professional lines; $2500 to $15,000 men exclusively; complete privacy assured; no commission charged—only service fee and postage. Send name and address only, in confidence, for prefatory details. R. W. Bixby (established 1910), P1 Niagara Square, Buffalo, N. Y.

POSITIONS WANTED

Connecticut

CHIEF ENGINEER open for position; 20 years' experience in large plants; highest efficiency assured; strictly temperate; best of reference. PW770—Power.

Illinois

ENGINEER WISHES POSITION as chief in small plant or assistant in large plant; 12 years' experience; A-1 references; will go anywhere. PW767—Power, Chicago.

New York

POWER-PLANT OPERATING ENGINEER or assistant; licensed man; experienced in the care and operation of engines, boilers and auxiliary equipment; immediately available; location immaterial. PW678—Power.

Virginia

BOILER SUPERINTENDENT and combustion engineer open for position; can handle any size or kind; prefer South or Western location. PW763—Power.

Civil-Service Opportunities

NEW YORK STATE CIVIL SERVICE—Open competitive examination for junior electrical engineer, Public Service Commission for the First District, $901.-$1200. per annum will be held throughout the State on May 6, 1916. Minimum age twenty-one years. At least three years' electric railroad, electric lighting or electrical or mechanical installation experience required. Open to non-residents. A number of temporary appointments pending the examination will be made. For further details, communicate with Public Service Commission for the First District, 154 Nassau Street, New York City.

BUSINESS OPPORTUNITIES

PRIVATE OFFICE and drafting facilities to sublet by established architects; central location; low cost. BO769—Power.

WANTED

WANTED FOR CASH or on royalty basis, patented electrical, mechanical or steam specialty or formula. W771—Power, Chicago.

MANUFACTURER wants either patented or patentable ideas on boiler and engine room specialties; cash or royalty basis. W676—Power.

AGENTS AND SALESMEN

HIGH-GRADE STEAM SPECIALTY SALESMAN, five years' experience with present firm; seeks connection with reliable firm; Philadelphia territory preferred. W768—Power.

AGENTS handling engine and boiler room specialties, in every section, for side line, paying large commissions. Give experience, lines carried and territory covered. W390—Power.

AGENTS on commission to sell our Shaking Grates; we will install grates on trial or put in on test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio.

AGENTS on commission to sell the new and successful Duplex Return Steam Trap; join a rapidly growing organization. Address American Duplex Steam Trap Co., 413 Moffat Block, Detroit, Mich.

HAVE YOU SUCCESSFULLY SOLD a steam specialty? You can make a profitable connection with an old-established line which sells to power plants everywhere; extensively advertised—unusually liberal contract. W731—Power, Chicago.

WELL-VERSED boiler-room and combustion men or established engineering agencies to sell mechanical stokers on a liberal commission basis; we manufacture three distinct types to meet all requirements; natural and forced draft. W749—Power, Chicago.

AGENCY for industrial and power-plant equipment by partnership of experienced salesman and mechanical engineer for Philadelphia territory; highest references furnished; only reliable companies considered; commission basis. Address Baker & Perkins, 1625 Real Estate Trust Building, Philadelphia.

MISCELLANEOUS

PATENT ATTORNEYS

PATENTS. C. L. Parker, patent attorney, formerly member Examining Corps, U. S. Patent Office, McGill Bldg., Washington, D. C. Inventor's handbook sent upon request.

IS YOUR INVENTION VALUABLE? Ask A. P. Connor, electrical, mechanical engineer (ex-chief electrical engineer for New York). Patent attorney. Lawyer. Carroll St., S. E., Washington, D. C.

For Sale

Second Hand Equipment

Rates: Less than 4 insertions 75 cents per line—4 to 11 insertions 70 cents per line—12 or more insertions 65 cents per line

Equipment Wanted items appear at the end of this list.

ADVERTISERS' NAMES are abbreviated in most of these items. Complete names and addresses are as follows:

POWER Mchy. Exchange, 14 Morris St., Jersey City, N. J.

BOILERS

1—54″x12′ Erie horiz. return tubular, butt strapped, 125 lb. —L. F. Seyferts Sons, Inc., 437 N. 3d St., Phila., Pa.

125 H.P. H.R.T. boiler, butt strap, triple riveted, 125 lb. pressure, $375.—POWER MCHY.

ENGINES, GAS

Westinghouse vertical, 40 hp., now running; in best possible condition. Selling because of purchase of a larger unit. Delivery immediately.—The Acklin Stamping Co., Toledo, O.

Two 25 K.W. Westinghouse 230 volt generators direct connected Westinghouse gas engines, $800 each; 12½ K.W. Crocker Wheeler 125 volt generator direct connected Nash vertical gasolene engine and switchboard, $475.—POWER MCHY.

ENGINES, STEAM

American Ball engine, 160 hp., 16″x14″, 250 r.p.m. with belt wheel 72″x15″, new, was never set on foundation. FS753—POWER.

14x30 Burlingame corliss, practically new, $475; 16x38 Rollins corliss, perfect condition, $500.—POWER MCHY.

18x42 Allis belted, double eccentrics, good as new. FS764—Power, Chicago.

GENERATING UNITS

1 Ridgway engine, 14x14, 124 hp., and 1 Ridgway dynamo, 75 kw., 250 volts; both practically new and form a unit.—The Ford Lumber & Mfg. Co., Winchester, Ky.

Two 1040 H. P. horizontal cross compound, heavy duty, mill type Buckeye engines 24″x42x36, 120 R. P. M. each direct connected to 500 K. W., 250 volt, Westinghouse Type "Q" generators. Excellent condition, good as new. Now in operation. If interested, write for full information and prices.—Box 197, Elyria, Ohio.

50 K.W. 230 volt generator direct connected Duplex engine, American Ball make, $700; 60 K.W. 125 volt generator direct connected Ideal engine, $500; 34 K. W. Crocker Wheeler 125 volt generator direct connected Skinner engine, $550.—POWER MCHY.

REFRIGERATING MACHINERY

50-Ton Cold Storage Plant—We have for sale a 10x20 two-cylinder, vertical, double acting De La Vergne cold storage plant, with a 20x20 horizontal steam cylinder. This machine is in excellent condition and all taken apart ready to put on the cars. Write us for price and particulars. The Touraine Confectionery Co., Causeway & Washington St., Boston, Mass.

TURBINES

We have customers who have installed larger equipment and are anxious to dispose of the following second-hand apparatus; 4 Sturtevant Turbines of horsepowers 10, 20, 24 and 35—Also one Electra Steam Turbine, 30 HP. 700 R.P.M., 155 lbs. steam pressure.—B. F. Sturtevant Co., Hyde Park, Boston, Mass.

WANTED

Corliss engine—One 20x42 or 22x42 simple engine of standard make and design, in first-class condition and guaranteed by seller. Give complete description. W765—Power.

Motor Generator Sets.—150 to 500 HP. 2300 volts or less, 2 phase-60 cycle. A. C. Motor. Generator 220-240 volts D. C. Must be in perfect condition. Any standard make. Address A. Brion, 417 Canal St, New York.

FOR SALE

Receiver's Sale

OF ALL THE PROPERTY OF THE
SOUTHERN IOWA RAILWAY & LIGHT COMPANY

On the third day of May, 1916, at two o'clock in the afternoon, at the North door of the Court House in Albia, Iowa. All the real, personal and mixed property of the Southern Iowa Railway and Light Company and the Albia Gas Company will be sold at a Receiver's sale to the highest bidder.

The property consists of Central Station buildings, Machinery and equipment, Car Barns and contents. Rolling Stock, Rights of Way, Rails, Ties, etc., of ten miles of street and interurban lines, Transmission and service lines, Heating Mains and service equipment, Gas Plant buildings, Machinery and equipment, Gas Mains and service equipment.

The Property has been operated by the Receiver since June 8, 1915. Statements of earnings and expenses for the period the Receiver has been in charge will be furnished interested parties.

Figures covering a recent appraisal of the property are also available. ALFRED C. MUELLER, Rec.,
Albia, Iowa.